3D TV

AIT50EF10
Market Perspective of the ICT Industry

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HD DVD (short for High-Definition/Density DVD) is a discontinued high-density optical disc format for storing data and high-definition video. Supported principally by Toshiba, HD DVD was envisioned to be the successor to the standard DVD format. However, in February 2008, after a protracted high definition optical disc format war with rival Blu-ray, Toshiba abandoned the format, announcing it would no longer develop or manufacture HD DVD players or drives. However, the HD DVD physical disk specifications (but not the codecs) are still in use as the basis for the CBHD (China Blue High-Definition Disc) formerly called CH-DVD. The HD DVD Promotion Group was dissolved on March 28, 2008.

1. History

3D technology can be traced all the way back to the beginning of photography. In 1844 David Brewster invented the Stereoscope. It was a new invention that could take photographic images in 3D. Later, Louis Jules took that invention and improved on it. Louis took a picture of Queen Victoria using the improved technology and displayed it at the Great Exhibition in 1851. This picture became very well known throughout the world. Stereoscopic cameras started to catch on and became fairly common for personal use by World War II.

In 1855 a stereo animation camera, was invented. It was able to create 3d motion pictures. In 1915 the first anaglyph movie was produced. Anaglyph technology used 3d glasses with 2 different color lenses that would direct an image to each eye. In 1890 William Greene, a British film pioneer, filed a patent for the 3D movie process. In 1922 the first public 3D movie, "The Power of Love", was displayed. In 1935 the first 3D Color movie was produced. The use of the technology would remain dormant for over a decade.

In the 1950s, 3D technology made a comeback. During this era, TVs had become extremely popular and had started appearing in many households. In the 50s a number of 3D movies were being produced. In 1952 "Bwana Devil" by United Artists was shown across the United States. This was the first 3D movie of the 50s. The film was shot using a process called Natural Vision. This process was pitched to Hollywood studios but they all passed. A year later, in 1953, "House of Wax" was released in 3D. "Dial M for Murder" was originally planned to be released in 3D, but Alfred Hitchcock decided to release the movie in 2D to maximize profits. Not all movie theaters were equipped with the 3D technology. 3D films were also being developed outside of the United States. In 1947 The Soviet Union released their first full length 3D movie, "Robinson Crusoe".

In the 1960s a new technology called Space-Vision 3D was released. This technology took two images and printed them over each other on a single strip. Unlike previous 3D technologies, it required a single projector with a special lens. This new technology removed the need to use two cameras to display 3D movies. Two camera systems were difficult to use, because it required that the two cameras were perfectly synced. The first movie to use this technology was "The Bubble". The movie was panned by critics, but the 3D experience still brought huge audiences. It became a profitable movie, making the new technology ready for promotion to other studios.

In 1970, Allan Silliphant and Chris Condon developed Stereovision. This was a new 3D technology that put two images squeezed together side by side on a single strip of 35 mm film. This technology used a special anamorphic lens that would widen the picture using a series of Polaroid filters. The first movie to be released in Stereovision was a soft-core sex comedy called "The Stewardesses". The movie cost only $100,000 USD to make and it earned an amazing $27 million in North America.

In the early 1980s many movies were released in 3D using the same process as Space Vision. Some of the movies that were released were Amityville 3-D, Friday the 13th Part III, and Jaws 3-D. In the mid 1980s, IMAX began producing documentary films in 3D. IMAX's 3D technology emphasized mathematical correctness and this eliminated the eye fatigue that was seen in previous 3D technologies. In 1986, Canada had developed the first 3D movie that used polarized glasses. It was called "Echos of the Sun" and was created for Expo 86.

During the 1990s, many films were released in IMAX 3D. The most successful IMAX 3D film released during this time was "Into the Deep". The first IMAX 3D fiction film, "Wings of Courage" was released in 1996.

During the 2000s, many big studio movies were released in 3D. In 2003, James Cameron released Ghosts of the Abyss. This was the first full length 3D IMAX feature film. This movie used the latest IMAX 3D technology called Reality Camera System. The technology used the latest HD video cameras and was developed by Vince Pace. This same technology was used in "Spy Kids 3D: Game over", "Aliens of the Deep", and "The Adventures of Sharkboy and Lavagirl in 3-D". In 2004 the first full length animated 3D movie was released. It was called "The Polar Express". This movie was so successful in 3D that it prompted a great interest in 3D animated films. The 3D version of the film earned 14x as much per screen as the 2D version. In 2005, The Mann's Chinese 6 theater in Hollywood became the first commercial movie theater to have the Digital 3D technology. In 2007 Scar 3D was released internationally and it was the first film to be filmed using a completely digital workflow.

In 2010 Sky UK made a big push towards 3D television. On January 1st, the first 3D channel began broadcasting in South Korea. The channel displays educational shows, animated shows, sporting events, documentaries and musical performances all in 3D, 24 hours a day, and 7 days a week.

We should expect that the use of 3D technology will continue and expand in to the normal household. Most major electronics manufacturers are planning the release of their 3D television lines. As the technology ages, expect prices to go lower and lower, and as they prices drop, more and more people will purchase 3D television sets.

2. 3D Films

3-D films have existed in some form since the 1950s, but had been largely relegated to a niche in the motion picture industry because of the costly hardware and processes required to produce and display a 3-D film, and the lack of a standardized format for all segments of the entertainment business.

Nonetheless, 3-D films were prominently featured in the 1950s in American cinema, and later experienced a worldwide resurgence in the 1980s and '90s driven by IMAX high-end theaters and Disney themed-venues.

3-D films became more and more successful throughout 2000–10, culminating in the unprecedented success of 3-D presentations of Avatar in December 2009 and January 2010.

In this golden era of the 3D TV, 3D films are being produced like "Avatar", bringing images projected onto a flat cinema screen to life in full three dimensional glories.

Looking at an object near us and closing our left and right eyes in turn, we will see that each has a slightly different view of the world. Your left eye sees a bit more of the left side of the object, and your right eye sees a bit more of its right side. Your brain fuses the two images together allowing us to see in three dimensions. This is known as **stereoscopic vision**, to create a similar effect, 3D films are captured using two lenses placed side by side, just like our eyes (or by producing computer generated images to replicate the same effect).

In old fashioned 3D films, footage for the left eye would be filmed using a red lens filter, producing a red image, and footage for the right eye would be shot using a blue filter, resulting in a blue image. Two projectors then superimposed the images on the cinema screen.

3D glasses with blue and red filters ensured viewers' left and right eyes saw the correct image: the red filter would only let red light through to your left eye, and the blue filter would only let blue light through to your right eye. Your brain would then combine these two slightly different images to create the illusion of 3D.

Unfortunately, this meant that old fashioned 3D films couldn't make full use of color, to get around this problem; modern 3D films use polarized light instead of red and blue light.

Stereoscopic motion pictures can be produced through a variety of different methods. Over the years the popularity of various systems being widely employed in movie theaters has waxed and waned.

The following are some of the technical details and methodologies employed in some of the most notable 3-D movie systems that have been developed.

2.1 Stereoscopic

The anaglyph method produces two slightly offset images, each individually tinted in either red or cyan. The red-cyan glasses then filter the light appropriately, meaning individual eyes only see the image meant for them. The brain then merges the two slightly different images to produce the 3D effect. This is the main process currently being used on 3D Blu-Ray releases and on TV broadcasts.

2.1.1 Anaglyph Method

The anaglyph method produces two slightly offset images, each individually tinted in either red or cyan. The red-cyan glasses then filter the light appropriately, meaning individual eyes only see the image meant for them. The brain then merges the two slightly different images to produce the 3D effect. This is the main process currently being used on 3D Blu-Ray releases and on TV broadcasts.
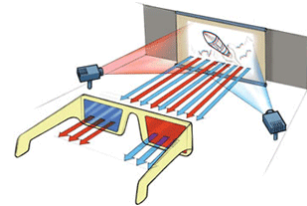
2.1.2 Polarization Method

The polarized method is one which is becoming the method of choice when displaying 3D images. Two images are projected at right angles to each other which are then filtered by the polarizing glasses, again meaning each individual eye only see the image intended for it, much in the same way as the anaglyph method. Polarization is the main method that will be used by 3D TV.
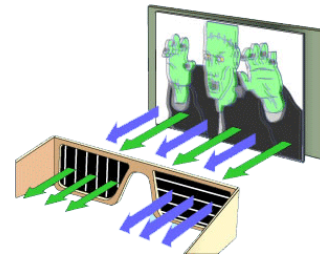
2.1.3 Active Shutter

Another method that uses glasses is known as Alternate-frame sequencing (Active Shutter). Left and Right images are played alternately at 48fps, and the glasses open and close the shutters over the eyes to ensure each eye sees the correct image.

This requires linking the glasses to the hardware playing the images to synchronize the opening and closing of the shutters via infrared, radio frequency, DLP-Link or Bluetooth. This method is currently the main method used by the likes of Samsung, Sony and LG on their 3D Displays.

*Some drawbacks of Active Shutter glasses

The constant shuttering might bother some who are very sensitive to low refresh rates and cause flickering.

Glasses are battery powered.

While the 3D displays using this technology will be inexpensive themselves, the glasses will be more expensive than their passive counterparts due to their complexity

2.2 Auto-stereoscopy

The final method involves no glasses at all, and is called Auto-stereoscopy. The method is not practical at this time for use in the home, although many manufacturers already have screen using the technology. In particular the Philips WOW VX uses this technology but was only made available to professional markets. Hopefully the technology will become available for the home at some point in the future!

2.3 Computer Generated Holography

Computer Generated Holography (CGH) is the method of digitally generating holographic interference patterns. A holographic image can be generated e.g. by digitally computing a holographic interference pattern and printing it onto a mask or film for subsequent illumination by suitable coherent light source. Alternatively, the holographic image can be brought to life by a holographic 3D display (a display which operates on the basis of interference of coherent light), bypassing the need of having to fabricate a "hardcopy" of the holographic interference pattern each time. Consequently, in recent times the term "computer generated holography" is increasingly being used to denote the whole process chain of synthetically preparing holographic light wavefronts suitable for observation.

Computer generated holograms have the advantage that the objects which one wants to show do not have to possess any physical reality at all (completely synthetic hologram generation). On the other hand, if holographic data of existing objects is generated optically, but digitally recorded and processed, and brought to display subsequently, this is termed CGH as well. Ultimately, computer generated holography might serve all the roles of current computer generated imagery: holographic computer displays for a wide range of applications from CAD to gaming, holographic video and TV programs, automotive and communication applications (cell phone displays) and many more.

Figure 1 – display human body parts in ultra-sharp resolution. **(Source: protomag)**

2.4 Volumetric Displays

A volumetric display device is a graphical display device that forms a visual representation of an object in three physical dimensions, as opposed to the planar image of traditional screens that simulate depth through a number of different visual effects. One definition offered by pioneers in the field is that volumetric displays create 3-D imagery via the emission, scattering, or relaying of illumination from well-defined regions in (x, y, z) space. Though there is no consensus among researchers in the field, it may be reasonable to admit holographic and highly multi-view displays to the volumetric display family if they do a reasonable job of projecting a three-dimensional light field within a volume.

Most, if not all, volumetric 3-D displays are auto stereoscopic; that is, they create 3-D imagery visible to the unaided eye. Note that some display technologists reserve the term "auto-stereoscopic" for flat-panel spatially-multiplexed parallax displays, such as lenticular-sheet displays. However, nearly all 3-D displays other than those requiring headwear, e.g. stereo goggles and stereo head-mounted displays, are auto-stereoscopic. Therefore, a very broad group of display architectures are properly deemed auto-stereoscopic.

Volumetric 3-D displays embody just one family of 3-D displays in general. Other types of 3-D displays are: stereogram / stereoscopes, view-sequential displays, electro-holographic displays, parallax "two view" displays and parallax panorama grams (which are typically spatially-multiplexed systems such as lenticular-sheet displays and parallax barrier displays), re-imaging systems, and others.

Although first postulated in 1912, and a staple of science fiction, volumetric displays are still under development, and have yet to reach the general population. With a variety of systems proposed and in use in small quantities — mostly in academia and various research labs — volumetric displays remain accessible only to academics, corporations, and the military.
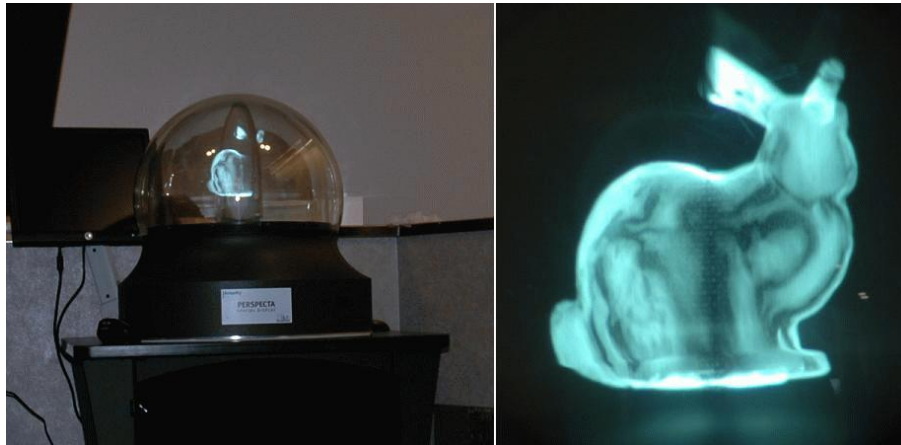
Figure 2 – The volumetric display generates 3D images. (**Source: cdn.physorg**)

3. What is a 3D TV?

- So, what exactly is a 3D TV? To put it simply, it is the latest gadget in the television world. As the name itself suggests, a 3D TV lends a three-dimensional effect to your favorite game show, movie, or video games in what is referred to as a stereoscopic effect.

- It relies on the use of stereopsis or separation (more commonly known in 3D viewing as parallax), to add the illusion of a third dimension to an otherwise two-dimensional flat image.

- There are two options of the 3D TV.

4.1 3D TV Options

4.1.1 3D-ready

3D-ready TV sets are those that can operate in 3D mode (in addition to regular 2D mode), in conjunction with a set-top-box and LCD shutter glasses, where the TV tells the glasses which eye should see the image being exhibited at the moment, creating a stereoscopic image. These TV sets usually support HDMI 1.4 and a minimum (input and output) refresh rate of 120 Hz; glasses may be sold separately.

Most 3D TVs will be labeled "3D-ready," meaning that they include an emitter to control the shutter glasses, but don't actually come with any glasses, it generally include Ethernet, USB player and recorder, Bluetooth and USB Wi-Fi.

LG, Samsung, Sony & Philips intend to increase their 3D TV offering with plans to make 3D TV sales account for over 50% of their respective TV distribution offering by 2012. It is expected that the screens will use a mixture of technologies until there is standardization across the industry. Samsung offers the LED 7000, LCD 750, PDP 7000 TV sets and the Blu-ray 6900.

On June 9, 2010, Panasonic unveiled a 152 inches (390 cm) 3D-capable TV (the largest so far) that will go on sale within 2010. The TV, which is the size of about nine 50-inch TVs, will cost more than 50 million yen (US$576,000).

4.1.2 3D-capable

3D-capable TVs lack the infrared emitter, so to watch in 3D you'd need to add an outboard emitter box along with as many pairs of 3D glasses as you need.

5. Encoding

5.1. Capture

Many techniques have been developed for the capture of 3D scene information. A common technique is based on shooting the scene simultaneously from different angles using multiple conventional 2D cameras.
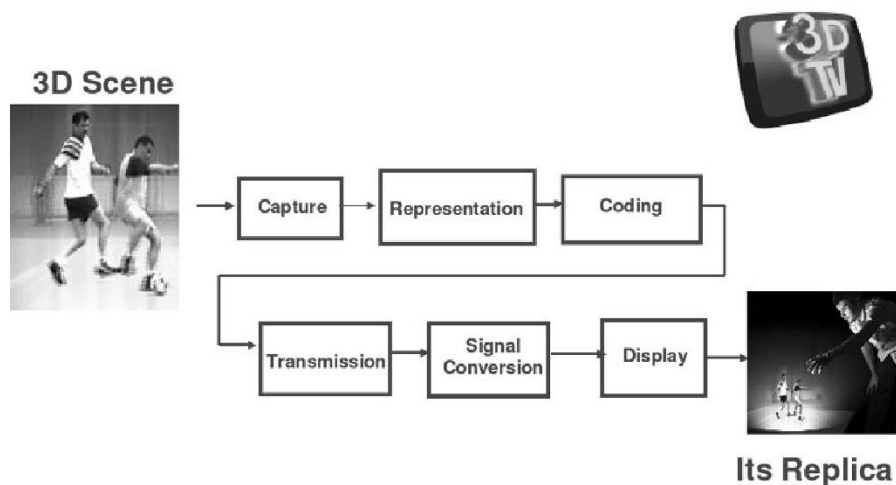
Fig. 3 Functional blocks of an end-to-end 3DTV system

In order to transform the captured data into the selected three-dimensional scene representation, Specific compression algorithms need to be applied for the different data types. Transmission over different channels requires different strategies. The vast amount of data and user interaction for FVV functionality essential to many systems complicates this task even further. On the receiver side, the data needs to be decoded, rendered, and displayed. In many cases this may require specific signal conversion and display adaptation operations. Interactivity needs to be taken care of. Finally, the images need to be displayed.

5.2 Recording Systems

When it comes to 3D recording, manufacturers employ different technologies that reflect different approaches to issues of picture quality and cost, depending on whether the target is consumer or professional use.

1) **LR independent**
- MPEG2 and H.264 are already established standards.
- AVC & MVC offer 1.5~2.0 times encoding capacity.

2) **Side-by-side**
- Uses existing transmission channel bandwidth.
- The picture signals for left and right eyes are compressed by 1/2 horizontally and then combined in a side-by-side format.
- Since this can be transmitted in the same way as a conventional TV signal,

it is widely used for creating 3D content and for TV broadcasting. In Japan, the 3D broadcasts on the BS11 satellite channel are of this type.

3) Frame (field) sequential

- Noticeable flicker.
- Uses existing transmission channel bandwidth.

4) Above-below

- Requires frame memory.
- Uses existing transmission channel bandwidth.

5) Line-by-line

- The picture signals for left and right eyes are interleaved in alternate lines.
- Widely used for computers equipped with polarizing 3D LCD monitors.

6) Checkerboard

- Filter degrades diagonal characteristics, but resolution can be increased through shifting pixels.
- High compatibility with the Smooth Picture technology (DLP shifting pixels) used to increase resolution for projectors.
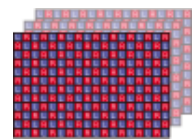
The side-by-side and top-bottom signal formats differ from the frame packing format in that they are tailored specifically for broadcast applications.

Broadcasters (including cable, satellite and over-the-air providers) must continue to support existing transmission standards; and since they are a multi-channel service rather than a dedicated source device (such as a BD Player) they need to adopt 3D transmission formats that fit within the current signal structure.

As a result, broadcasters must support "frame compatible" 3D signal formats such as side-by-side and top-bottom. By doing so, the multi-channel service provider can deliver 3D signals transparent to the existing devices connected to their network.

Combining Recording and display technologies

Viewing with circular polarizing system

3D content recorded using the side-by-side format is converted to line-by-line format inside the TV (or by separate converter) for viewing with filter and circular polarizing glasses. This is the same as for the JVC display demonstration.

Recording → Display
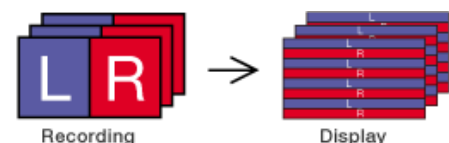
• Viewing with checkerboard system

LCD television: 3D content recorded using the checkerboard format is converted to line-by-line format inside the TV (or by separate converter) for viewing with filter and circular polarizing glasses.

Plasma television: 3D content recorded using the checkerboard format is converted to frame (field) sequential format inside the TV (or by a separate converter) for viewing with shutter-type (active) glasses.
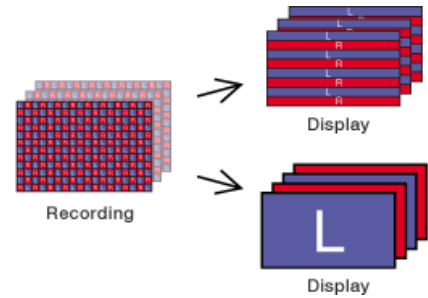
• Viewing full HD x 2 channels frame sequential format

24p or 60i footage is recorded using the full HD x 2 channels frame sequential format. The TV performs I/P conversion and displays at 120p (60p for left, 60p for right); active glasses are used for viewing.
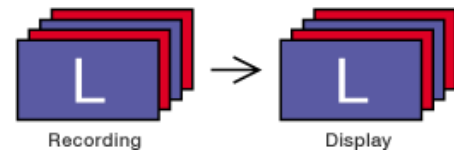
5. 3D Transmission

Europe's DVB organization is attacking the standards problems covering 3D transmission.

DVB describes 3D as the "hottest subject in the media world today", the DVB want to Faze 1 of their action in place by the end of this year.

"Broadcasters in different parts of the world have announced their intention to start 3DTV broadcasting this year (2010), "There are test broadcasts currently available, or soon to be available, by satellite, and among other events, certain football matches in the 2010 World Cup will be shot in 3DTV," says the DVB Project.

The DVB Project has responded to this with a program of work which should lead to standards for 3DTV, The current plan is that the first phase of the 3DTV system (the Phase 1 system) will be agreed this year, the DVB Project has established two groups of specialists. The first is currently preparing the commercial requirements for 3DTV.

The second will respond with a technology that will meet the requirements. The technical system, once agreed by all concerned, will be submitted to the ETSI and ITU.

There are 2 types of transmission effects: **interlaced and progressive scanning:**

Interlace is a technique of improving the picture quality of a video signal without consuming extra bandwidth. Interlaced video was designed for display on CRT televisions.

Interlaced scan refers to one of two common methods for "painting" a video image on an electronic display screen (the other being progressive scan) by scanning or displaying each line or row of pixels. This technique uses two fields to create a frame. One field contains all the odd lines in the image, the other contains all the even lines of the image. A PAL based television display, for example, scans 50 fields every second (25 odd and 25 even). The two sets of 25 fields work together to create a full frame every 1/25th of a second, resulting in a display of 25 frames per second.

To display interlaced video on modern progressive scan displays, a complex process called deinterlacing should be applied to the video signal or video data stored on a media.

Despite arguments against it and the calls to leave interlacing to history by many prominent video experts and technological companies such as Yves Faroudja, the founder of Faroudja Labs and Microsoft, creators of VC-1 codec, interlacing continues to be supported by the television standard setting organizations and is still being included in new digital video transmission formats such as DV, DVB, and ATSC. Some new generations of video compression standards currently in development, like High-efficiency Video Coding, target high-definition progressive video and do not support interlaced formats.

Progressive or noninterlaced scanning is a way of displaying, storing or transmitting moving images in which all the lines of each frame are drawn in sequence. This is in contrast to the interlacing used in traditional television systems where only the odd lines, then the even lines of each frame (each image now called a field) are drawn alternately.

The system was originally known as "sequential scanning" (actually a more technically correct description) when it was used in the Baird 240 line television transmissions from Alexandra Palace, England in 1936. It was also used in Baird's experimental transmissions using 30 lines in the 1920s.

6. How 3D Broadcasting Works?

We perceive depth because the right eye and the left eye are in different locations and each eye captures an ever so slightly different image. The brain processes the two different images into a single image enabling us to focus and perceive the world around us with a sense of depth.

The central principle behind 3D TV is exactly the same – two different images are displayed and then shown to the left eye and right eye. The footage shown to the eyes is recorded from two slightly different perspectives, either from two different cameras, or a camera with two lenses.

This footage is then interlaced into one image and broadcast to 3D-ready TVs which are then able to polarize (separate) the original 3D broadcast back into separate images. They appear on the screen as blurred images – but when viewed through 3D glasses, the separate images are directed to either the right eye or left eye, creating the impression of depth.
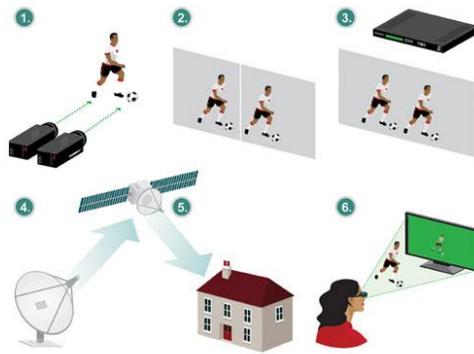
Figure 4: Figure 4: How 3D Broadcasts works (Source: Sony)

7. What you'll need to experience 3D TV in your home

- **A TV screen designed for 3D:** You can choose from LCD or plasma models, but all 3D TVs use a specially designed screen that can actually display two different versions of a video image by alternating the video frames at very high speed.
- **Active 3D glasses for each viewer:** Anyone watching a 3D TV needs to be wearing glasses to see the three-dimensional effect. 3D TV glasses are far more technologically advanced than the disposable glasses handed out in movie theaters. 3D TV requires wireless "active" glasses battery-powered liquid-crystal "shutter" glasses, which can lighten or darken hundreds of times per second to alternately block out the left or right lens in coordination with the video frames flashing on screen. To anyone not wearing shutter glasses, a 3D TV picture will look blurry and distorted.
- **An infrared emitter:** The third piece of the 3D puzzle is an "emitter" — usually built into the TV that communicates wirelessly with the 3D glasses via infrared beams. The emitter's job is to precisely control the timing of the shutter glasses to synchronize with the video flashing on the screen.
- **A 3D video source:** And finally, a true 3D experience begins by feeding your TV a 3D video signal. The best example is a 3D-capable Blu-ray player playing a 3D movie.

A source device to provide a 3D signal is a device such as a 3D Blu-ray player, or in short, a piece of equipment connected to your TV that is able send 3D signals to your TV. Listed below are the most common types of source devices that can or will be able to send 3D signals. However, there may be other types of devices introduced in the future.

1) 3D Blu-Ray player - when purchasing a Blu-ray player for 3D, make sure it is marked as a 3D Blu-ray player. If it is not marked 3D, it cannot supply a 3D signal to your TV. In addition, the Blu-ray disc itself must be marked 3D. Yes, 3D Blu-ray players can play regular 2D Blu-ray discs, just as Mitsubishi 3D and 3D Ready TVs can display 2D content. 3D-enabled Blu-ray players simply add the ability to play a 3D Blu-ray disc and send a 3D signal when playing these discs. Blu-ray players that are not labeled as 3D cannot send a 3D signal and cannot play 3D-enabled Blu-ray discs.

2) Cable Box - many of the high definition cable boxes already in homes today will be able to receive and send 3D channels in the Side-by-Side and/or Top-Bottom 3D signal format. Existing high definition cable boxes will be upgraded in consumers' homes by their cable company when the cable company is ready to deliver 3D channels. If you are a cable TV subscriber, you will need to check with your local cable TV provider to find out the details.

3) Satellite Receivers - again, like cable boxes, many of the existing high definition satellite receivers will be able to be updated by your satellite service provider to deliver 3D channels in the Side-by-side and possibly Top-bottom 3D signal formats. If you are a satellite TV subscriber, you will need to check with your satellite TV provider to find out the details.

4) Video Game consoles - Sony has provided upgrades to the Playstation[®] 3 gaming console to provide the ability to play selected games in 3D. They also recently announced updates that will allow the Playstation 3 to play 3D Blu-ray discs and send 3D signals[*]. The upgrade for 3D game playing has been tested and shown to be compatible with the Mitsubishi 3D adapter. It should be noted that, as of this writing, some games for the PS3 such as James Cameron's Avatar have been written to provide a 3D signal in several 3D formats without this upgrade. The setting for the Checkerboard 3D display format has been shown to be compatible with all Mitsubishi 3D Ready and 3D TVs. While a formal announcement from other game console manufacturers have not been made, James Cameron's Avatar game for Xbox 360 also has the compatible Checkerboard 3D format setting.

5) Home Theater PCs - NVIDIA has had PC graphics cards and drivers for several years that will play 3D video and convert PC games to 3D. Also a company called DDD has software drivers named "Tri-Def" 3D. There are settings in these systems that are compatible with all Mitsubishi 3D Ready and 3D TVs. Please visit the NVIDIA 3D Vision site or the Tri-Def web site for detailed system requirements and updates to the drivers that may allow you to play 3D Blu-ray discs in 3D.

Most 3D TVs will also include special video processing circuitry that converts standard 2D video to 3D. Naturally, the result won't look as good as true 3D content.

 To ensure compatibility, choose a TV and 3D glasses made by the same company. Blu-ray 3D players and home theater receivers seem to work fine with 3D TVs from different brands.

8. Standardization

It feels like we've been here before… Currently there is no industry wide standard for 3D TV's and as such there may be some compatibility issues between different hardware. Therefore how future proof an early purchase may be might only surface with time, that's not to say you shouldn't get stuck in! There is though thankfully a defined standard with 3D Blu-ray.

- The entertainment industry is expected to adopt a common and compatible standard for 3D in home electronics. To present faster frame rate in high definition to avoid judder, enhancing 3-D film, televisions and broadcasting, other unresolved standards are the type of 3D glasses (passive or active), including bandwidth considerations, subtitles, recording format and a Blu-ray standard.

- With improvements in digital technology, in the late 2000s, 3D movies have become more practical to produce and display, putting competitive pressure behind the creation of 3D television standards. There are several techniques for Stereoscopic Video Coding, and stereoscopic distribution formatting including anaglyph, quincunx, and 2D plus Delta.

- Content providers, such as Disney, DreamWorks, and other Hollywood studios, and technology developers, such as Philips, asked SMPTE for the development of a 3DTV standard in order to avoid a battle of formats and to guarantee consumers that they will be able to view the 3D content they purchase and to provide them with 3D home solutions for all pockets. In August 2008, SMPTE established the "3-D Home Display Formats Task Force" to define the parameters of a stereoscopic 3D mastering standard for content viewed on any fixed device in the home, no matter the delivery channel. It explored the standards that need to be set for 3D content distributed via broadcast, cable, satellite, packaged media, and the Internet to be played-out on televisions, computer screens and other tethered displays. After six months, the committee produced a report to define the issues and challenges, minimum standards, and evaluation criteria, which the Society said would serve as a working document for SMPTE 3D standards efforts to follow. A follow-on effort to draft a standard for 3D content formats was expected to take another 18 to 30 months.

- Production studios are developing an increasing number of 3D titles for the cinema and as many as a dozen companies are actively working on the core technology behind the product. Many have technologies available to demonstrate, but no clear road forward for a mainstream offering has emerged.

- Under these circumstances, SMPTE's inaugural meeting was essentially a call for proposals for 3D television; more than 160 people from 80 companies signed up for this first meeting. Vendors that presented their respective technologies at the task force meeting included Sensio, Philips, Dynamic Digital Depth (DDD), TDVision, and Real D, all of which had 3D distribution technologies.

- However, SMPTE is not the only 3D standards group. Other organizations such as the Consumer Electronics Association (CEA), 3D@home Consortium, ITU and the Entertainment Technology Center at USC's School of Cinematic Arts (ETC), have created their own investigation groups and have already offered to collaborate to reach a common solution. The Digital TV

Group (DTG), has committed to profiling a UK standard for 3DTV products and services. Other standard groups such as DVB, BDA, ARIB, ATSC, DVD Forum, IEC and others are to be involved in the process.

- MPEG has been researching multi-view, stereoscopic, and 2D plus depth 3D video coding since the mid-1990s; the first result of this research is the Multi view Video Coding extension for MPEG-4 AVC that is currently undergoing standardization. MVC has been chosen by the Blu-ray disc association for 3D distribution. The format offers backwards compatibility with 2D Blu-ray players.

- HDMI version 1.4, released in June 2009, defines a number of 3D transmission formats. The format "Frame Packing" (left and right image packed into one video frame with twice the normal bandwidth) is mandatory for HDMI 1.4 3D devices. All three resolutions (720p50, 720p60, and 1080p24) have to be supported by display devices, and at least one of those by playback devices. Other resolutions and formats are optional. While HDMI 1.4 devices will be capable of transmitting 3D pictures in full 1080p, HDMI 1.3 does not include such support. As an out-of-spec solution for the bitrate problem, a 3D image may be displayed at a lower resolution, like interlaced or at standard definition.

9 Applications of 3DTV

- More mainstream application for the displays is likely to be video games.

- Home Entertainment: 3DTV For Sport / Live Events / Films / Documentaries

- They can be used in hospitals as part of training, or in the military.

- The range of applications of 3D TV and vision are manifold and has a potentially powerful impact on all our lives. Because of the breadth of such applications, we can only mention a few of the more representative ones.

- multi-target tracking for football applications, Air traffic control

- the development of MEMS for display development

- motion capture with standard video techniques

- virtual tours in cultural heritage

- Simulation of forest fire propagation

- the technologies required for 3D in the mobile domain

However, even then we have only "scratched the surface" of the potential applications which will open up for a user-friendly, comfortable, interactive 3D display.

10. Market Analysis
10.1 Introduction

No other recent technological advancement can be claimed to be as exciting and inclusive as 3D media. 3D blockbusters in the cinema, 3D sports events in pub`s and now the ability to watch 3D content from the comfort of your own home are revolutionizing the way in which almost all forms on on-screen entertainment are enjoyed by people throughout the world.

With the underlying technology continuing to grow and adapt the potential for a full 3D home viewing experience can now be realized with little more than a 3D compatible television, 3D glasses and any form of 3D content. 3D content in itself is growing rapidly, with live broadcasts of sporting events now possible, accompanied by traditional television programming in 3D.

In this boom of 3D related products, it is important for the consumer to bear in mind the plethora of products available and make informed decisions as to the best decision available to them in regards to price and performance.

Designer 3D sunglasses are undoubtedly a promising innovation but may not be suitable for every consumer. Equally, projectors may be more suited to certain situations than traditional television monitors and some more suited to gaming over films. As such, it is imperative that the average consumer is aware of all the options open to them when making a purchase.

Owing to the fast paced nature of change in the industry, it also hugely important that the average consumer has the ability to weigh up any purchase`s ability to change and adapt along with the requirements of the industry. This fast paced change need not deter potential buyers, as a well made purchase could allow the user to enjoy both existing technology and future developments such as 3D gaming.

The DVD player is a hugely relevant example of a way in which a consumer can know before they buy any piece of 3D technology the capabilities of the product as well as its durability with regards to changes within the industry and advancements in usage of existing technology. Use of a service such as this would leave the 3D market place a far more open and transparent area of business and benefit not only the individual consumer but those interested in purchasing 3D technology as a whole. In terms of progress in home entertainment 3D technology is undoubtedly the shining light. It has the potential to completely revolutionize the viewing experience from a mundane everyday experience to one that is entertaining in its own right.

The number of consumers watching television in the third dimension in their homes, and the quality of their experiences will increase significantly over the next few years. There is the vision that the format will be taking off in the home over the next few years as technology continues to improve and impediments, relative to consumers wearing active or passive glasses and the need for more content are surmounted.
Technology will improve all around in years ahead and that will bring more eyes to 3D sets.

Is 3D TV the Wave of the Future or Just a Hyped Up Vision?

While 3D televisions are being introduced as the "new" next best technological development in television, the 3D concept has been around for more than 150 years. In 1844 the first stereoscope, a camera capable of taking 3D pictures, was introduced. In 1851 a picture of Queen Victoria was displayed in 3D at The Great Exhibit ion. By 1855, a Stereo Animation Camera was invented, and the first 3D movie, "The Power of Love", was released in 1922. As television became more popular in t he 1950's, more 3D movies were produced, including a special version of "House of Wax" in 1953. None of this pushed consumers to demand 3D television sets or manufacturers to start producing 3D sets – until now. Duet of significant advances in technology, the 3D experience has reached new heights and depths – visually.

SUPPLY

Highly competitive market competes relentlessly for market share. The marketplace for televisions is extremely competitive as manufacturers compete for valuable market share and seek economies of scale necessary to make a profit. Consumers usually benefit from this competition, with falling prices and razor thin profit margins. But volume makes this arena an attractive place for businesses to compete. The Nielsen Company reports, that in the U.S., there continues to be on average, more televisions per home (2.86 sets) than people (2.5 people). From 1975 to 2009, the average number of televisions sets per household increased every year. This presents a tremendous opportunity for sales.

Imports drive supply, domestic production has all but vanished. As price became a more dominant factor in purchasing decisions, U.S. manufacturers turned to low-wage countries to produce product at more competitive prices. This exodus has resulted in no remaining significant production of flat panel televisions domestically. In February 2009, Sony closed it s last manufacturing facility in the U.S. Supply of televisions is almost entirely driven by imports, which themselves fell in 2009.

DEMAND

Availability and type of content key driver of demand; youth will lead the charge.

Companies who are vested in the manufacturing of hardware and publishing/ broadcasting will be working the hardest to produce content to drive demand. Sony is the best example of this. In 2010, the company will be releasing the 3D enabled BRAVIA television set. At t he same time, Sony Pictures Entertainment began releasing movies on Blu-ray, starting with "Cloudy with a Chance of Meat balls" on January 5, 2010. Playstation®3 is working to upgrade consoles to 3D. Here's a snapshot of what's happening on three key content fronts.

Television:

A variety of television net works have been testing the waters of 3D broadcasts. ESPN plans on featuring at least 85 sporting events during 2010 in 3D. These events will include the 2010 FIFA World Cup, college foot ball, college basket ball and Summer X Games. According to ESPN, the network has been testing 3D broadcasting for over two years, showing select event s t o sample audiences to test the

effectiveness of the broadcast. Sporting events and video games are a few of the most likely uses of 3D TV's. Initially, to be able to broadcast in 3D, simultaneous with standard broadcasting, a second product ion crew is needed. 3D poses more challenges than standard broadcasts, since two images are required in order to create the 3D effect - at least two cameras must be used. One camera creates the image for the left eye, and second camera creates the image for the right eye.

This process requires precision from t he camera crew and post -product ion, as an individual film has to be produced for each eye. Both films must then be processed to work simultaneously. Tools are being developed to make the filming process more seamless for live transmission, merging the hardware of the cameras with the soft ware that manipulates lighting, color and spacing.

Initially, broadcasts were available in select theaters, now, though ESPN is launching the ESPN 3D Network on June 11, 2010, which will be available t o paying subscribers with the home technology to utilize it. Direct TV announced three 3D HD channels will launch in 2010. Partners include CBS, Fox Sport s and HDNet, plus DirecTV will be making their own content.

Movies:

For several years, filmmakers have been investing in the product ion of 3D films. Avatar's recent blockbuster success around t he globe brought tremendous advancement s in technology. In 2009, we saw the following hit the screens in 3D: Coralline, Monsters vs. Aliens, Up, Ice Age: Dawn of t he Dinosaurs, G-Force, Toy Story (rerelease), A Christmas Carol, Planet 51 and Avatar. Dozens more t it les have been announced for 2010. Animators are getting in on t he game first, meaning that kids, who are most willing to adopt new technologies, are being reached first.

Video games:

Video games have always embraced t he cutting edge in development. So it's no surprise that this industry is breaking new ground with 3D technology. Sony has already announced that firmware upgrades will be available later t his year for t he PlayStation 3 console, which will give users the ability to play 3D movies and games without having t o upgrade t o a new PlayStation device (a 3D enabled television set is still needed however). Other video game publishers, such as Ubisoft and NVIDIA, have also indicated their plans on expanding their software to be 3D compatible. For more information on 3D video games, and the video gaming industry, please refer to the industry insight on Video Games.

Pace of technological advancement may be too fast for some buyers. For some customers, obsolescence may be t heir biggest concern. A short time ago, t he HDTV plasma and LCD screens were the epitome of high end television. With technology advancing at ever increasing rates, new advancements are fighting to stay current for more than a year or two. Thus, one of t he largest hurdles manufacturers will face is convincing consumers that 3D technology is here for the long run and t hat movies, sports and television are making significant effort s t o provide more content and programming that will be supported effectively by 3D TV' s for years to come. It may take a while to convince families who recently upgraded their sets to an LCD HDTV t hat t hey need a new television set. Thus, at least in t he short run, less price sensitive early adopters will lead t he charge.

Glasses – a new cost consideration t hat will impact demand

In addition to the television sets themselves, glasses are a new, costly requirement. While some manufacturers are pushing to develop 3D TVs t hat do not need special glasses, the current models do require them to achieve the 3D experience. And the polarized version used in the movie theatres will not work as t hey are specifically designed to work with the theatre screen – and not the home 3D TV. Panasonic's TVs are being sold with one pair of 3D Active Shutter glasses – with additional glasses available for $149.95 each. Samsung is promoting two pairs of it s Active Shutter glasses in their "3D Starter Kit", with additional pairs averaging $150. 00 each, and Sony, which also provides two pairs with its TV, offers additional pairs at $133.00 each. With the average family size of 2.5 people, this will require an additional investment in at least one pair, at a minimum. If your family size is more than the average, t his could result in an additional, significant investment. This might be a big deterrent to some consumers considering upgrading to the new technology, especially at the current price points for the TV and the glasses. Not to mention, glasses are easily lost and broken. Having a party at your house featuring your favorite sporting event? Want to enjoy a 3D movie with a bunch of friends? You will either need plenty of extras to share or you may want to add onto your invitations – BYOG – Bring Your Own Glasses.

Discretionary spending

With double digit unemployment and slow job growth on the horizon, discretionary purchases of 3D televisions are likely not at the top of t he list of many households right now. In January 2010, t he Bureau of Economic Analysis reported that disposable personal income (DPI) dropped $47.6 billion, or 0.4 percent. A pick up in discretionary income will be necessary for the product to go mainstream.

Clyde Robbins, a distinguished member of the technical staff of Motorola Mobility, on the "Winning Over 3DTV's Front-Row Fans" panel, which was part of the Nov. 18 event hosted by ***Multichannel News***, ***Broadcasting & Cable***, ***TWICE***, ***TV Technology*** and ***Videography***. Tricia Lynch, senior programming executive, Verizon, said FiOS was pleased with its test of producing the Sept. 2 NFL preseason game between New York Giants and New England Patriots in 3D from the New Meadowlands Stadium and delivering the contest to its customers in New York, New Jersey, Massachusetts and Rhode Island. She called the event "incredibly successful" based on the number of "enthusiastic" phone calls the company received, a total of 4,000 between the two markets. Verizon also was pleased with the quality of the telecast, when feedback helped the producers focus more on "the best seats in the house" view and find about consumer appetite for 3D movies on demand.

Things will begin to change toward a more passive 3D world shortly. Consumers have to weigh the 3D cost equation at home by gauging the combined cost of the set and the glasses. While passive sets cost more, the attendant glasses are not priced as highly as the active ones. The situation is reversed relative to active sets with its considerably more expensive and carefully designed glasses. 3D adoption tale will unfold in a similar manner as HD did. Content providers need to create compelling stories and programming that will create interest and demand and then work with distributors to get the product out there and there are parallels between adoption of HD several years back and what lies ahead for 3D. However, the nascent technology holds an advantage because its HD predecessor laid the

groundwork for today's consumers, who are now more knowledgeable about the value/quality of LCD and plasma sets.

Based on the global reviews and trends about the 3D TV industry we gathered a few charts which depict the current situation and projections about the future. Consequently, our Market Analysis consists of several charts with have to do with the 3D market forecasts for the next decade, the demands for 3D TVs by geographical region, technology and brand.

Through all these charts we have an overall picture about what the situation looks like for 3D display.

We begin our market analysis by presenting the global forecasts for 3D display industry.

10.2 Global 3D Forecasts in numbers

3D Display Revenues Forecast to Reach $22B by 2018;

3D-Ready TV Shipments to Reach 64M Units

In its recently released 3D Display Technology and Market Forecast Report, it is forecasted that the total stereoscopic 3D display market will grow from 0.7 million units and $902 million in revenues in 2008 to 196 million units and $22 billion in revenues in 2018, a compound annual growth rate (CAGR) of 38% for revenues and 75% for units.

The market for 3D displays—which is encouraged by the recent success of 3D cinema—is forecast to take off in 2010, providing a welcome boost to the electronics industry. "3D displays are taking off with consumers due to increasing availability of 3D content. In addition, 3D standardization has also been addressed or is being evaluated in several 3D organizations," noted Jennifer Colegrove, Director of Display Technologies at Display Search. "A number of manufacturers of consumer electronics devices, including TVs, monitors, notebooks, Blu-ray disc players, and digital cameras/camcorders/photo frames have aggressively promoted 3D in the home. In addition to consumer use of 3D displays, the technology has also been used for many professional applications and advertisement/public displays."

It is forecasted that 3D-ready TVs will grow from 0.2 million units in 2009 to 64 million units in 2018. 3D-ready TV will be the largest application in terms of revenue in 2018 with $17 billion.

The following chart shows what the expected revenues as well as the units (forecasted to be sold) for 3D TV during the next ten years:
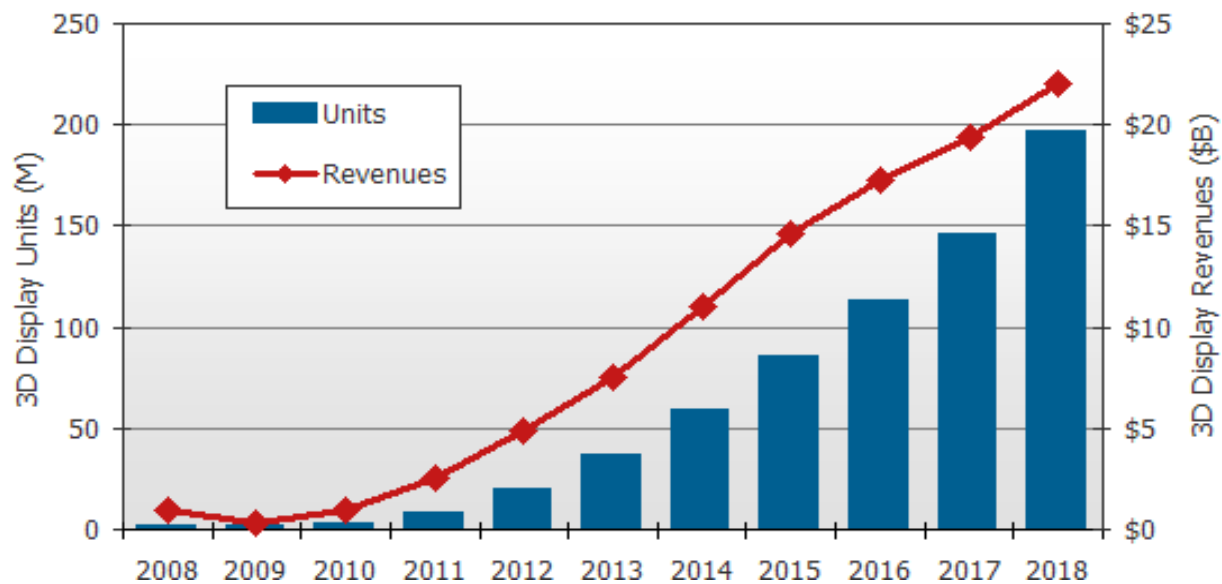
Figure 4: 3D Display Forecast

The Interpretation of the data of the figure above is the following:

- 3D-ready monitors will grow from 40K units (0.02% penetration) in 2009 to 10 million (3.6% penetration) in 2018.
- 3D notebook PCs are forecast to grow from 66K units (0.04% penetration) in 2009 to 17.7 million (3.2% penetration) in 2018.
- Mobile phones will be the largest 3D display application on a unit shipment basis in 2018, with 71 million units with 3D capability.
- The largest screen size category for 3D display shipments will be 1-4.x", due to demand from mobile phone and digital camera/camcorder applications. The second largest size range will be 40-49", due to TV, public display and 40+ monitor applications.
- LCD will be the primary display technology used for 3D displays, as a result of its wide range of display applications ranging from small mobile phones to large public displays and TVs.
- Eyewear will be necessary for most 3D applications for many years to come, due to the limitations of auto-stereoscopic (no glasses) technologies.
- It is forecasted that there will be more than 7,000 new 3D cinema screens installed in 2010 and an additional 9,000 in 2011.

10.3 Projections for shipments by region for the next 5 years

It's not uncommon in the tech world for there to be a slow uptake of a new product category when it first launches. There is a clear case of chicken or the egg in many new categories, HDTVs went through a similar process where there was little content at first for the HDTV buyer to view on their fancy sets and networks didn't want to provide more content until there was a larger user base.
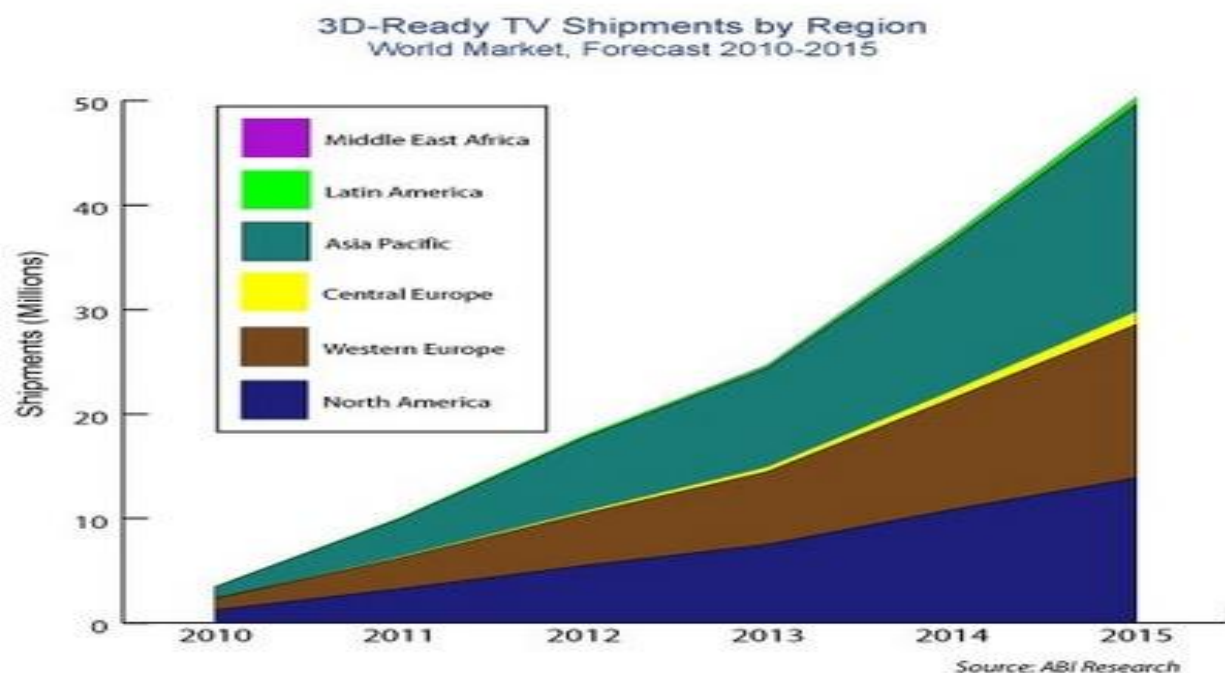
Figure 5: 3D TV Shipments by Region

The 3D TV market will spend the next couple of years establishing itself and accumulating a base of content and devices (both TVs and Blu-ray players). In 2013 market growth will start to accelerate and shipments of 3D TV sets will approach 50 million in 2015.

3D TV is facing this same thing right now. TV makers expected consumer to flock to 3D TV but most have stayed away thanks to cost, the need for glasses, and the fact that content is scarce right now. That content scarcity is changing though and as the years tick by more and more folks will switch to 3D TV. A new report that pegs 2015 as the year 3D TV will really boom has been issued.

According to the research firm in 2015 global shipment of 3D TVs will hit the 50 million mark. By 2011, the global shipments will hit about 10 million with 2013 being fingered as the year that shipments really take off. The big catalyst for this growth is likely to be not only more content available, but also the fact that sets needing no glasses are expected by then.

10.4 The 3DTV industry by technology

Interestingly, 3D TV Technology has long been existing for numerous years now. This unique engineering science is now currently being observed in not only the movie industry, but at the present, there is definitely an explosion of 3D technological innovation also being made attainable to the consumer in the HDTV market place. There are currently products being launched to the television market place which are in the market today for purchase and use in your personal Home 3D Theater experience.

On this web page I will disclose what choices in addition to technological innovations are now on the market and being bought as well as exactly what might be attainable in the future. It is questionable as to how soon many of these products and this kind of innovative technological innovation are going to be snapped up by eager buyers. There are actually leaders of companies that are investing huge monetary resources in the improvement of this new wave of 3D technologies and who believe that inside the next 10 years the sale of 3D products will encompass HALF of their television sales income! We've already had the Consumer Electronics Show 2010 and there are actually a number of ideas that we can learn from the event. We now have found out that the tablet PC is going to be huge as well as 3D TV technology. Looking back at the show, a variety of consumer electronics makers had samples of this new upcoming 3D technology on showcase. The manufacturers ranged from Panasonic, JVC, Samsung as well as others. This technological innovation was certainly the "talk of the show". There are lots of manufacturers which are seeing the writing on the wall and are now scrambling to put in place innovations, compatible solutions and products so that they can claim a share within this potentially explosive market. For example, Interactive TV Today is taking a closer overall look at each and every 3D TV from the 2010 CES and has picked out some companies that they are waiting to see what they will be providing during the New Year. Cable Labs is offering testing capabilities for 3D TV implementation on cable. These vary from frame-compatible to spatial multiplexing solutions. JVC has announced that they are going to be launching a brand new IF-2D3D1 Stereoscopic Image Processor that will actually convert 2D to 3D. This will ensure it is considerably less difficult for 3D content producers to work with their archived 2D subject matter. Comcast announced at CES that they are intending to launch a video on demand service. Movie pictures already anticipated to show up include "The Final Destination," "My Bloody Valentine," and many more. ESPN will launch a 3D channel in June and is planning on delivering in excess of 85 live games. Organizations like Panasonic and Mitsubishi are already working on a wide variety of HD 3D enabled TVs. Inside the television industry; this is looked at as the 1st big improvement after the introduction of flat panel TV sets. Sony is likewise showing interest in this particular latest technology that is being popularized with new 3D movies hitting the cinema such as Avatar. So, the "gold rush" is on and increasing in momentum. Organizations are spending huge amounts of financial resources in the creation of devices and solutions including positioning themselves for the future demand and possibilities yet to come. Timing and the most beneficial choices are now extremely important. There will be chances for new and existing manufacturers to take huge leaps forward. Small companies that tend not to lead, or at least closely follow, these new revolutions will simply disappear into the past.

The next wave of the MPEG digital video revolution and our project's core is 3DTV or in technical terms stereoscopic video. Stereoscopic video uses the 2D images in order to create the 3D perception .The 3DTV technique is that 2D image is selectively targeted at either the left eye or right eye , affecting the brain's natural depth sensing abilities.

There are several prevailing technologies in the 3D TV market, including LCD, OLED and PDP. While LED-backlit LCD displays have become the dominant type, new OLED displays and PDP are still being produced with 3D support. In fact, PDP and plasma displays had been capable of 3D several years before LCD due to their naturally high refresh rates. Opting for a plasma or PDP-based display has its benefits; namely in terms of saving cash, but also in larger screen size. Many LED and PDP displays leave it up to the inputting device, such a Blu-ray player or game system, to provide the stereoscopic processing,

reducing production costs, and thus keeping the cost down for consumers. But that being said, 2D-to-3D conversion isn't possible, and while many 3D-enabled LCDs may have built-in active shutter transmitters, some LED and PDPs require external peripherals.

In our analysis we are going to present what the market looks like for 3DTV globally, but first we are going to give the definitions of 2D as well as 3D prevailing technologies .As we mentioned before these technologies are LED, LCD, CRT as well as RP and OLED.

The prevailing ones for 3D TV are LCD, OLED and PDP and the transition from CRT technology to LCD happened just in a few years as we are going to see in the following figures.

10.5 3D TV Technological segmentation

The major technologies used in TV are the following:

Technology	Description
LCD:	(Liquid Crystal Display) – It uses the light modulating properties of liquid crystals (LCs) and do not emit light directly. LCD technology is divided in LED &CCFL displays. The structure comprises the pixels and output polarizer of the base LCD, a twisted nematic (TN) LC polarization switch, and a Polarization Activated Microlens, which has a surface relief structure formed in an isotropic material and an adjacent layer of birefringent lens LC material. In the 2D mode, the polarization state that leaves the panel is rotated 90° by the switch LC material and is then incident on the normal refractive index of the lens LC. This has the same refractive index as the isotropic material so that there is an index match at the isotropic lens surface, and no optical function is produced. In the 3D mode, a voltage is applied to the TN switch which reorients the switch LC material so that it no longer has a polarization rotating function. The output polarization state from the TN switch is incident on the extraordinary refractive index of the lens LC, so that there is an index step at the interface to the isotropic lens, and the lens function is produced.
PDP:	(Plasma Display Panels) – They are inherently high-speed devices and they are called "plasma" displays because the pixels rely on plasma cells, or what are in essence chambers more commonly known as fluorescent lamps. A panel typically has millions of tiny cells in compartmentalized space between two panels of glass. These compartments, or "bulbs" or "cells", hold a mixture of noble gases and a minuscule amount of mercury. Plasma displays should not be confused with liquid crystal displays (LCDs), another lightweight flat-screen display using very different technology. LCDs may use one or two large fluorescent lamps as a backlight source, but the different colors are

	controlled by LCD units, which in effect behave as gates that allow or block the passage of light from the backlight to red, green, or blue paint on the front of the LCD panel.
OLED:	(Organic Light Emitting Diode) –It uses the same technology as LED TV's but it is made out of organic material. Polarization Activated Microlenses cooperate with the circular polarizer often used to cancel light reflection from internal electrodes. Randomly polarized light from the panel enters the birefringent microlens and sees both the lensing and non-lensing functions of the lens array. In the 2D mode, the polarization state corresponding to an index match at the lens interface is rotated by the TN switch and transmitted through the output polarizer. In the 3D mode, the output polarizer transmits the orthogonal polarization state that passed through the lens seeing an index step.
RP:	(Rear Projection) – TV's based on this technology have fallen out of favor due to the massive popularity of LCD and Plasma Televisions and is a type of large-screen television display technology. Up until the mid-2000s, most of the relatively affordable consumer large screen TVs (up to 100 in (2,500 mm)) used rear projection technology. A variation is a video projector, using similar technology, which projects onto a screen.
	Rear projection television has been commercially available since the 1970s, but at that time could not match the image sharpness of the CRT. Current models are vastly improved, and offer a cost-effective HDTV large-screen display. While still thicker than LCD and plasma flat panels, modern rear projection TVs have a smaller footprint than their predecessors. The latest models are light enough to be wall-mounted.
CRT:	(Cathode Ray Tubes) - CRT screens have deeper cabinets compared to flat panels and rear-projection displays.
	A cathode ray tube is a vacuum tube which consists of one or more electron guns, possibly internal electrostatic deflection plates, and a phosphor target. In television sets and computer monitors, the entire front area of the tube is scanned repetitively and systematically in a fixed pattern called a raster. An image is produced by controlling the intensity of each of the three electron beams, one for each additive primary color (red, green, and blue) with a video signal as a reference. In all modern CRT monitors and televisions, the beams are bent by magnetic deflection, a varying magnetic field generated by coils and driven by electronic circuits around the neck of the tube, although electrostatic deflection is commonly used in oscilloscopes, a type of diagnostic instrument.

The most common technologies used for 3DTV's are LCD, PDP and OLED.

The 3D LCD TV generally adopts the liquid crystal faceplate that 240Hz drives, in addition in some products, still adopt LED to carry scanning of the illuminator, etc. and reduce cross talk phenomenon, etc. and improve the measure at the same time. The television manufacturers plan to expand 3D video products battle array. However, especially in the picture size of less than 30 inches, if adopting 240Hz faceplate, the cost will increase, thus bring the restriction to low price.

The present development direction is to improve the vision signal or speed of response in order to improve the liquid crystal faceplate.

10.5.1 The worldwide TV market technological transition (2004-2013)
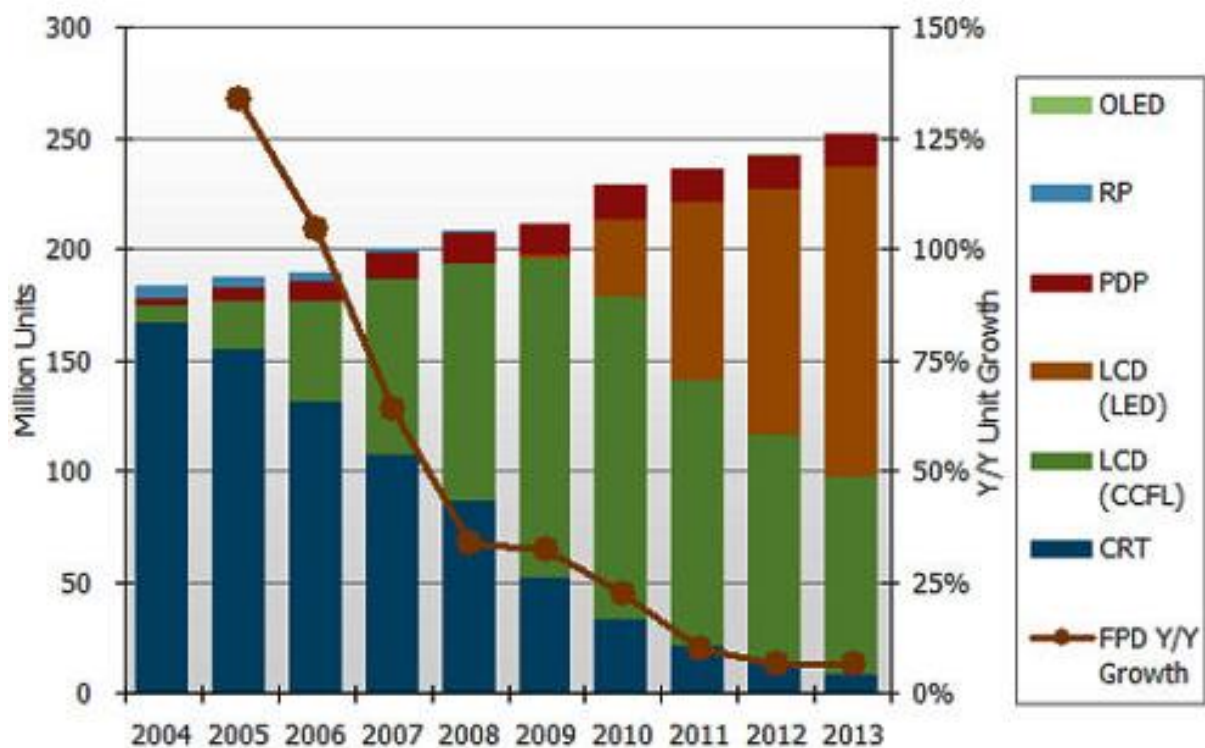
Figure 6: TV Technological Transition

This chart shows how the worldwide TV market is segmented for the different technologies. The transition from CRT to LCD TVs is clearly stated.

10.5.2 3D TV Market by Technology (2010-2014)

With product offerings from all leading TV vendors now available, shipments of 3-D TVs are expected to reach 3.4 million in 2010 and grow to 42.9 million in 2014, according to market research firm Display Search. Based on this forecast, 3-D TV market penetration is expected to grow from a 5 percent share of total flat panel TVs in 2010 to 37 percent in 2014, according to the firm's latest report.

"TV manufacturers have managed to launch products very rapidly. We have seen a full range of 3-D TVs in sizes from 40 inches to 63 inches already available, and without a doubt, there will be another wave of new products at the IFA show in Berlin in September," said Paul Gray, director of TV electronics research at Display Search, in a statement. Paul Gagnon, director of North America TV research at DisplaySearch, said only Panasonic and Samsung launched 3-D TVs in the U.S. in the first half of 2010. "Based on early indications, the launch of 3-D TVs is similar to Samsung's rollout of LED LCD TVs at the beginning of 2009, albeit at a slightly slower pace," Gagnon said. "This would be in line with our forecast of just over 2 million 3D T-Vs shipped in North America for 2010." Despite the forecasted growth for 3-D TV, content remains limited to a small number of movies and a few sports events on pay TV, DisplaySearch said. Hit movies that were offered in theaters in 3-D, such as Avatar, will not be available for 3-D TV this year, DisplaySearch (Santa Clara, Calif.) said. The low market penetration of Blu-ray players, and especially HD broadcasts, outside of North America and Japan also affects content availability.

Figure 7: 3D Display Forecast

This is the 3D TV technologies scenery for the following years.

Comments on 3DTV industry forecasts (2010-2014)

✓ Despite the forecasted growth for 3D TVs, the 3D content for TV remains limited to a small number of movies and some sports events on pay TV (reliant on cable providers). Blockbuster movies in 3D, such as Avatar, will not be available for 3D TV in 2010.

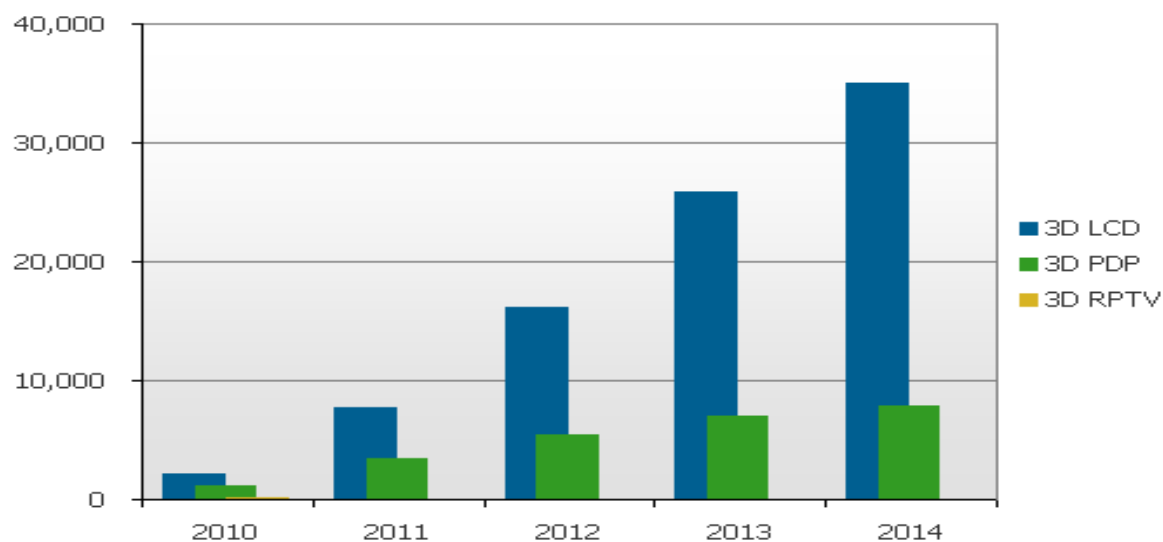✓ The low penetration of Blu-ray players or HD broadcasts, outside North America and Japan affects content availability. Consumers may be tempted to wait for the ecosystem to evolve in order to have enough material to watch.

✓ Other technologies, such as LED backlighting, are important. Analysis of the latest energy regulations shows how much progress has been made.

10.6. 3D Market by vendor

VENDOR	DESCRIPTION
VIZIO	Vizio is a privately-held producer of consumer electronics, based in Irvine, California, USA. It was founded in October 2002 as V Inc. Vizio currently produces primarily LCD televisions. Amtran, a Taiwan-based company, is one of a number of investors in Vizio. As of August 22, 2007, Vizio became the largest LCD TV seller in North America, with 606,402 TVs sold in the second quarter of 2007, a 76% jump from the previous quarter. Its market share increased from 9.4% to 14.5%.In September 2008, Vizio started selling LCD TVs to Costco in Japan. In February 2009, Vizio announced they would stop production of plasma televisions. At the CES 2009 Vizio introduced a 240 Hz LED-backlit VF551XVT 55" LCD TV. Vizio has also started making other Audio/Video equipment such as High Definition Surround Sound Systems, LCD computer monitors and HDTV accessories. The company released its first Blu-ray Disc player in August 2009. **History** The company started in 2002 with $600,000 and only three employees. In 2006 the revenue was estimated around $700 million, and in 2007 it was estimated to have exceeded $2 billion. Vizio is known for aggressively pricing their HDTVs against major competitors. On October 19, 2010, Vizio signed a 4-year contract to sponsor the college football's annual Rose Bowl game in Pasadena, California, beginning with the 2011 Rose Bowl presented by Vizio and ending with the 2014 Vizio BCS National Championship Game. Samsung Electronics is the world's largest electronics company with 2009 revenue of $117.4 billion, headquartered in Samsung Town, Seoul, South Korea. It is the flagship subsidiary of the Samsung Group. With assembly plants and sales networks in 65 countries across the world, Samsung has as many as 157,000 employees. In 2009, the company took the position of the world's biggest IT maker by surpassing the erstwhile leader Hewlett-Packard. Its sales revenue in the areas of LCD and LED displays

Samsung	and computer chips is the world's No. 1. Some of the most popular items produced by Samsung include LED TVs and Galaxy S mobile phones. Even though consumers may not realize, many non-Samsung-brand devices such as TVs and phones have Samsung-manufactured memory components inside. In the TV segment, Samsung's market position is dominant. For the four years since 2006, the company has been in the top spot in terms of the number of TVs sold, which is expected to continue in 2010 and beyond. In the global LCD panel market, the company has kept the leading position for eight years in a row. With the Galaxy S model, Samsung's smartphone lineup has retained the second-best slot in the world market for some time. In competition to Apple's iPad tablet, Samsung released the Android powered Samsung Galaxy Tablet.
LG	**LG Corp.** is the second largest Korean conglomerate company. LG produces electronics, chemicals, and telecommunications products and operates subsidiaries like LG Electronics, LG Display, LG Telecom and LG Chem in over 80 countries. LG Corp. founder Koo In-Hwoi established Lak-Hui Chemical Industrial Corp. in 1947. In 1952, Lak-Hui (pronounced "Lucky", currently LG Chem) became the first Korean company to enter the plastics industry. As the company expanded its plastics business, it established Gold Star Co., Ltd., (currently LG Electronics Inc.) in 1958. In 1995, to better compete in the Western market, the company was renamed "LG", the abbreviation of "Lucky Gold star". More recently, the company associates the letters LG with the company tagline "Life's Good". Since 2009, LG also owns the domain name LG.com. LG 3D TV brings the ultimate immersive viewing experience into the consumer's living room, with sports, videogames, documentaries and blockbuster movies bursting out of the screen. With LG, the consumer can experience the same breathtaking 3D effects that he's seen in the cinema from his own sofa.
	Panasonic Corporation is one of the largest electronic product manufacturers in the world, comprised of over 680 companies. It manufactures and markets a wide range of products under the Panasonic brand to enhance and enrich lifestyles all around the globe. The history of Panasonic goes back to when Konosuke Matsushita founded Matsushita Electric House wares Manufacturing Works in 1918. See how the company evolved and developed into one of the leading electronics companies in the world today.

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Panasonic	The belief in basic management objective to devote ourselves to the progress and development of society and the well-being of all people around the globe has been the foundation of the company. When Panasonic engineers set out to develop a home-use 3D theater system, they insisted on finding a way to bring the same exact power and realism that you see in a 3D cinema, right into the living room. The result was Full HD 3D. For movies and other 3D content, they developed a system in which the original HD image quality is captured for each eye, left and right, and recorded in full-HD quality on large-capacity Blu-ray Discs. By reproducing these HD image frames at ultrahigh speed for each eye, left and right, they were able to bring cinema-like 3D realism into your living rooms.
Toshiba	Toshiba Corporation is a Japanese multinational conglomerate corporation, headquartered in Tokyo, Japan. The company's main business is in infrastructure, consumer products, electronic devices and components. Toshiba-made Semiconductors are among the Worldwide Top 20 Semiconductor Sales Leaders. In 2009, Toshiba was the world's fifth largest personal computer vendor, after Hewlett-Packard of the U.S., Dell of the U.S., Acer of Taiwan, and Lenovo of China. Toshiba is a diversified manufacturer and marketer of electrical products, spanning information & communications equipment and systems, Internet-based solutions and services, electronic components and materials, power systems, industrial and social infrastructure systems, and household appliances. At October 2010 - Toshiba has announced Toshiba Regza GL1 21" LED backlit LCD TV glasses-free 3D prototype at CEATEC 2010. The system support 3D capability without glasses (integral imaging system of 9 parallax images with vertical lenticular sheet as used in Philip's Dimenco). The retail product 20" GL1 and 12" GL1 will be released at December 2010.
Sharp	Sharp Corporation is Japanese multinational corporation that designs and manufactures electronic products. Headquartered in Abeno-ku, Osaka, Japan, Sharp employs more than 64,500 people worldwide as of September 30, 2010. The company was founded in September 1912. It takes its name from one of its founder's first inventions, the Ever-Sharp mechanical pencil, which was invented by Tokuji Hayakawa in 1915. Since then it has developed into one of the leading electronics companies in the world. As a semiconductor maker, Sharp is among the Worldwide Top 20 Semiconductor Sales Leaders and among the Top 100 R&D Spenders in a list published by IEEE Spectrum magazine. It gained greater public awareness in the United Kingdom when it sponsored Manchester United F.C. from 1982 to 2000, which was a period of great success for the

club.

Sharp took a controlling stake in Pioneer Corporation in 2007. On 25 June 2009, they agreed to form a joint venture with Pioneer on their optical business to be called "Pioneer Digital Design and Manufacturing Corporation".

Sharp presented its first 3D LCD TV panel on April 2010. The products based on this technology have unprecedented picture quality for 3D TVs. In particular, color rendition is astonishingly bright and brilliantly clear. Moreover, Sharp has been able to reduce undesirable double-contour "ghost images" to a minimum through the perfect interplay of innovative LCD TV technologies such as UV2A, Quattron and Super Edge LED Backlight. Sharp uses shutter technology to create the impression of 3D images. Viewers must therefore wear special "shutter glasses" to watch 3D content.

Sony

Sony Corporation is the electronics business unit and the parent company of the Sony Group, which is engaged in business through its eight operating segments – Consumer Products & Devices (CPD), Networked Products & Services (NPS), B2B & Disc Manufacturing (B2B & Disc), Pictures, Music, Financial Services, Sony Ericsson and All Other.[5][6] These make Sony one of the most comprehensive entertainment companies in the world. Sony's principal business operations include Sony Corporation (Sony Electronics in the U.S.), Sony Pictures Entertainment, Sony Computer Entertainment, Sony Music Entertainment, Sony Ericsson, and Sony Financial. As a semiconductor maker, Sony is among the Worldwide Top 20 Semiconductor Sales Leaders.

In 3D TV market by using high-frame rate LCDs with a "frame sequential display", Sony makes it possible to watch Full HD 3D quality video on 3D compatible "BRAVIA" LCD TVs. This technology involves alternately transmitting images for the left eye and right eye to the screen. When viewed through the "active shutter glasses", the two separate images on the shutter glasses are synchronized with the onscreen image with their Full HD quality intact and precisely transmitted to the viewer's eyes. The high-quality super-fine Full 3D HD images deliver unprecedented reality and presence.

The following chart indicates what percentage of the 3D market belongs to each brand:

Sales

- Sony 12%
- Toshiba 8%
- LG 8%
- Sharp 5%
- Others 31%
- Vizio 18%
- Samsung 18%
- 0%
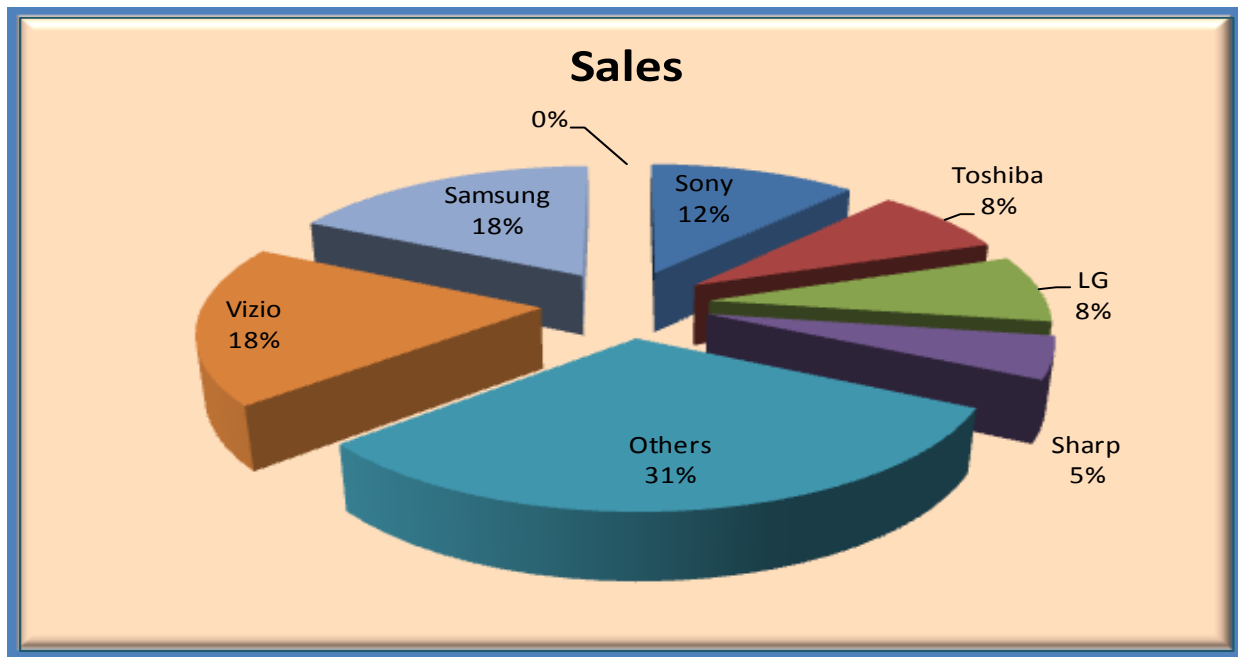
Chart 1: Sales by Vendor Worldwide

11. Blu Ray vs HD DVD

11.1. Blu-ray Technology for DVDs

A current, single-sided, standard DVD can hold 4.7 GB (gigabytes) of information. That's about the size of an average two-hour, standard-definition movie with a few extra features. But a high-definition movie, which has a much clearer image, takes up about five times more bandwidth and therefore requires a disc with about five times more storage. As TV sets and movie studios make the move to high definition, consumers are going to need playback systems with a lot more storage capacity.

Blu-ray is the next-generation digital video disc. It can record, store and play back high-definition video and digital audio, as well as computer data. The advantage to Blu-ray is the sheer amount of information it can hold:

A single-layer Blu-ray disc, which is roughly the same size as a DVD, can hold up to 27 GB of data -- that's more than two hours of high-definition video or about 13 hours of standard video.

There are even plans in the works to develop a disc with twice that amount of storage. The Blu-ray Disc Association (BDA) today announced the finalization and release of the "Blu-ray 3D" specification.

It leverages the technical advantages of the BD format to deliver "unmatched picture quality" as well as uniformity and compatibility across the full range of Blu-ray 3D products, both hardware and software. The specification is also designed to allow the PS3 to play back Blu-ray 3D content in 3-D.

Notably, the specification allows every player and movie supporting it to deliver full HD 1080p resolution to each eye. Moreover, the specification is display agnostic, meaning that Blu-ray 3D products will deliver the 3-D image to any compatible 3-D display, regardless of whether that display uses LCD, plasma or other technology and regardless of what 3-D technology the display uses to deliver the image to the viewer's eyes. Regarding compatibility, the specification supports playback of 2-D discs in forthcoming 3-D players and can enable 2-D playback of Blu-ray 3D discs on the installed base of Blu-ray Disc players currently in numerous domestic facilities around the world.

"Throughout this year, movie goers have shown an overwhelming preference for 3-D when presented with the option to see a theatrical release in either 3-D or 2-D," said Victor Matsuda, chairman, BDA Global Promotions Committee. "We believe this demand for 3-D content will carry over into the home now that we have, in Blu-ray Disc, a medium that can deliver a quality Full HD 3-D experience to the living room." "From a technological perspective, it is simply the best available platform for bringing 3D into the home," said Benn Carr, chairman, BDA 3D Task Force. "The disc capacity and bit rates Blu-ray Disc provides enable us to deliver 3D in Full HD 1080p high definition resolution."

11.2. HD Technology for DVDs

HD DVD (short for High-Definition/Density DVD) is a discontinued high-density optical disc format for storing data and high-definition video. Supported principally by Toshiba, HD DVD was envisioned to be the successor to the standard DVD format. However, in February 2008, after a protracted high definition optical disc format war with rival Blu-ray, Toshiba abandoned the format, announcing it would no longer develop or manufacture HD DVD players or drives. However, the HD DVD physical disk specifications (but not the codecs) are still in use as the basis for the CBHD (China Blue High-Definition Disc) formerly called CH-DVD. The HD DVD Promotion Group was dissolved on March 28, 2008.

Because all variants except 3× DVD and HD REC employed a blue laser with a shorter wavelength, HD DVD could store about 3 times as much data per layer as its predecessor

(Maximum capacity: 15 GB per layer instead of 4.7 GB per layer).

12. Content Availability

In hopes of capitalizing on the public's burgeoning thirst, Hollywood studios are cramming 3D content into more films and TV manufacturers are equipping gear so that it showcases the technology in people's living rooms.

But as much as consumers demand 3D in theaters, they may not quickly usher it into their homes. Making a living room theater 3D-capable can cost upwards of $4,000, a hurdle that even the most ardent 3D backers say may slow adoption. "We don't expect to see an explosion of 3D in the home until the 2012 time frame," says Mike Fasulo, chief marketing officer for Sony Electronics, which nevertheless is betting its future on the technology. Sony is among the electronics makers that plan to introduce 3D-friendly TVs and DVD players at the Consumer Electronics Show, due to begin Jan. 7 in Las Vegas.

Sony (SNE) expects 3D TVs to account for up to 50% of its total TV shipments in the financial year that ends March 2013, up from zero percent this year. To that end, the company is adding 3D capabilities to content from its movie and television studio, PlayStation 3 video gaming business, and broadcasting equipment arm. Though Panasonic (PC) was one of the biggest early proponents of 3D technology, Sony hopes to claim leadership over its biggest rivals, including Samsung and LG. Early movers typically can charge more for their products before prices inevitably slide. "We're uniquely positioned," Fasulo says.

More 3D Entertainment in the Works

Spurred on by the success of films such as *Avatar*, other Hollywood studios are throwing their weight behind 3D entertainment. All future Disney (DIS) and DreamWorks Animation SKG (DWA) animated titles will be available in 3D, and other filmmakers increasingly are incorporating the technology in movies, concert recordings, and sporting events. Satellite-television provider DirecTV (DTV) plans to introduce a 3D channel in 2010.

Widespread support from studios and device makers has prompted the consumer electronics industry to move ahead with unprecedented alacrity in creating standards for delivering 3D content to the home. "In this situation, we've got the creators and device makers both running to market 3D as quickly as possible," Fasulo says.

It can take years for players to agree to industrywide standards for cutting-edge technologies. Manufacturers began collaborating on a high-definition video standard in February 2002 before splintering into rival camps. The strife wasn't resolved till February 2008. By contrast, 3D standards were agreed upon in just 18 months. In late December, the Blu-ray Disc Assn. approved protocols for delivering 3D from high-definition discs to HDTVs. "The good news is that by having everyone aligned, we can make this an easy upgrade decision for consumers," says Andy Parsons, chairman of the Blu-ray Disc Assn.

Costly Home Equipment

Consumers may not move so quickly in adopting 3D for the home, however. To enjoy the full benefits of 3D technology, consumers need televisions with ultrafast screen refresh rates and new cables that can transport the gigantic 3D files from Blu-ray players to the set. That typically means they'll need both a new Blu-ray player and new big-screen television. And if customers want the surround-sound experience

they get in movie theaters, they'll need to purchase a new multimedia receiver, too. Add in special glasses required to view the three-dimensional effects, and the price tag can climb to at least $4,000.

That helps explain why few of the other manufacturers placing big 3D bets expect an overnight demand boom. LG predicts it will sell just 400,000 3D TVs in 2010, a fraction of the 25 million high-definition sets it will produce. Panasonic and Samsung are also among manufacturers expected to introduce new 3D sets at CES or soon afterward, but executives at both companies expect only modest sales in 2010. Research firm DisplaySearch forecast the 3D TV market to reach $1.1 billion in 2010 and grow sharply to $15.8 billion by 2015.

It's a sizable prize in itself, but manufacturers see other reasons for chasing 3D dreams. The technology can spur sales of big-screen televisions and Blu-ray players. Only about half of U.S. households have purchased their first high-definition TV. And makers of TVs and Blu-ray players are trying to convince consumers who already have a single HDTV set in the home to upgrade to newer, more expensive models. With 3D, consumers will view particular brands as technology standouts. And that, says Sue Shim, Samsung's senior vice-president for sales and marketing, "can lead to selling all kinds of models.

12.1 3D TV Channels

According to research made by the CEA, a large proportion of consumers will be considering purchasing a 3D TV set in the near future. However the availability of 3D content seems to be still the major obstacle for adoption.

According to the CEA and Entertainment and Technology Center at the University of Southern California, 67%t of those planning to buy a 3D TV within the next three years said they will be more likely to buy if they can receive and watch 3D television programs through an antenna, cable, satellite or fibre-to-home. The majority stressed that the main reason for buying a 3D TV is to watch 3D movies.

Virgin Media, the cable television company, aims at offering 3D TV content to its subscribers. This will be enabled through an on demand service. The provider gave up its prior decision to launch an exclusive 3D TV channel. Customers will need special 3D glasses to view the 3D content. Virgin Media plans to exhibit its 3D TV content, made up of films, TV and games, at the Ideal Home Show, at Earls Court in London. One can buy glasses at different rates. There are both budget and hi-end versions of the glasses. Virgin Media differentiates from its competitor BSkyB by offering on demand 3D products.

Sky Channel 3D appears to be the first of the 3D TV channels that we are expecting to see, but this one goes on air in United Kingdom only, sometime in April. And they already did some interesting tests by broadcasting a football match between Arsenal and Manchester United in a few different pubs in London, Manchester, Cardiff and Edinburgh. And this test received quite good feedback from the people that were lucky to be actually watching the game in 3D. Have in mind that the April launch seems to be only related to having the 3D sports content being pushed to a wider number of pubs and not to the general public.

DIRECTV (names unknown), backed up by Panasonic should be starting up 3 dedicated 3D channels in the USA. They should be available beginning in June 2010, with customers of the DIRECT TV HD service getting free software upgrade enabling them to have access to the new 3D channels through their 3D-ready television sets. DIRECTV's new 3D channels will deliver movies, sports and entertainment content. Also DIRECTV is currently working with AEG/AEG Digital Media, CBS, Fox Sports/FSN, Golden Boy Promotions, HDNet, MTV, NBC Universal and Turner Broadcasting System to develop additional 3D programming that will debut in 2010-2011. At launch, the new DIRECTV HD 3D programming platform will offer a 24/7 3D pay per view channel focused on movies, documentaries and other programming, a 24/7 3D DIRECTV on Demand channel and a free 3D sampler demo channel featuring event programming such as sports, music and other content.

ESPN 3D is another channel that will be offering sports programs starting this summer (in USA), beginning June 11 with the first 2010 FIFA World Cup match South Africa vs. Mexico. The network plans to feature at least 85 live sporting events during its first year, but they'll probably have other non-live sports content to fill in the holes, but the channel will most likely not be airing content 24/7 at first. Among the planned sports events to be aired live in 3D are up to 25 World Cup matches, the 2011 BCS National Championship Game, college basketball and football and the Summer X Games.

Canal+ 3D will be the first 3D TV channel in France with a launch date planned before Christmas 2010. The new 3D channel will broadcast movies, live events, sports and animation. With the current set-top boxes available to satellite subscribers of Canal+ said to be already compatible with the upcoming 3D broadcast, the only thing that remains is for the viewers to get a hold of a 3D-ready TV set.

3D Pictures is set to launch its own 3D TV channel by the end of this year in Spain. The new channel should be made available to the users via IPTV, satellite, cable, different mobile devices and so on. The channel is currently negotiating with suppliers of content such as sports, movies, concerts, entertainment, documentaries, animation, plays, circus, current affairs and high profile live events.

Discovery 3D (most likely name) by Discovery Communications, partnering with Sony and IMAX is another 3D TV channel competitor expected to launch in 2011 (in USA), but with plans to have content 24/7, unlike some early competitors. The program of the channel will feature high-quality premium content from genres that are most appealing in 3D, including natural history, space, exploration, adventure, engineering, science and technology, motion pictures and children's programming from Discovery, Sony Pictures Entertainment, IMAX and other third-party providers.

12.2. 3D Episodes and Shows

- There have been several notable examples in television where 3D episodes have been produced, typically as one hour specials or special events.

- The first-ever 3D broadcast in the UK was an episode of the weekly science magazine The Real World, made by Television South and screened only in the south-east region of the UK in February 1982. The program included excerpts of test footage shot by Phillips in the Netherlands. Red/green 3D glasses were given away free with copies of the TV Times listings magazine, but

the 3D sections of the program were shown in monochrome. The experiment was repeated nationally in December 1982, with red/blue glasses allowing color 3D to be shown for the first time. The program was repeated the following weekend followed by a rare screening of the Western Fort Ti starring George Montgomery and Joan Vohs.

- The sitcom 3rd Rock from The Sun two-part episode "Nightmare On Dick Street", where several of the characters' dreams are shown in 3D. The episode cued its viewers to put on their 3D glasses by including "3D on" and "3D off" icons in the corner of the screen as a way to alert them as to when the 3D sequences would start and finish. The episode used the Pulfrich 3D technique.

- Recent uses of 3D in television include the drama Medium and the comedy Chuck. The show Arrested Development briefly used 3D in an episode.

- Channel 4 in the UK ran a short season of 3D programming in November 2009 including Derren Brown and The Queen in 3D.

- On 31 January 2010, BSKYB became the first broadcaster in the world to show a live sports event in 3D when Sky Sports screened a football match between Manchester United and Arsenal to a public audience in several selected pubs.

- In April 2010, the Masters Tournament was broadcast in live 3D on DirecTV, Comcast, and Cox.

- On 29 May 2010, Sky broadcasted Guinness Premiership Final in 3D in selected pubs and clubs.

- Fox Sports broadcasts the first program in 3D in Australia when the Socceroos played The New Zealand All Whites at the MCG on May 24, 2010

- The Nine Network broadcasts the first Free-to-air 3D telecast when the Queensland Maroons faced the New South Wales Blues at ANZ Stadium on May 26, 2010.

- The Roland Garros tennis tournament in Paris, from May 23 to June 6, 2010, was filmed in 3D (center court only) and broadcast live via ADSL and fiber to Orange subscribers throughout France in a dedicated Orange TV channel.

- 25 matches in the FIFA World Cup 2010 were broadcast in 3D.

- The Inauguration of Philippine President Noynoy Aquino on June 30, 2010 was the first presidential inauguration to telecast in live 3D by GMA Network. However, the telecast was only available in select places.

- The 2010 Coke Zero 400 will be broadcast in 3D on July 3 on NASCAR.com and DirecTV along with Comcast, Time Warner, and Bright House cable systems.

- The 2010 AFL Grand Final will be broadcast in 3D from the Seven Network.

- Avi Arad is currently developing a 3D Pac-man TV Show.

- Satellite delivered Bell TV in Canada began to offer a full time pay-TV, 3D channel to its subscribers on 27 July 2010. In September 2010, the Canadian Broadcasting Corporation's first

3D broadcast will be a special about the Canadian monarch, Queen Elizabeth II, and will include 3-D film footage of the Queen's 1953 coronation as well as 3D video of her 2010 tour of Canada. This will mark the first time the historical 3D images have been seen anywhere on television as well as the first broadcast of a Canadian produced 3D program in Canada.

• The 2010 PGA Championship was broadcast in 3D for four hours on August 13, 2010, from 3–7 pm EDT. The broadcast was available on DirecTV, Comcast, Time Warner Cable, Bright House Networks, Cox Communications, and Cablevision.

• FioS and the NFL partnered to broadcast the September 2, 2010, pre-season game between the New England Patriots and the New York Giants in 3D. The game was only broadcasted in 3D in the northeast.

• Singapore based Tiny Island Productions is currently producing Dream Defenders, which will be available in both auto-stereoscopic and stereoscopic 3D formats.

• Rachael Ray (TV series) aired 3D Halloween Bash on October 29, 2010.

13. 5 Infant Problems of 3DTV

3D TV along with Apple's new iPad is forming a hot trend in consumer electronics. However in these early days consumers might want to wait for the technology to mature before making a purchase decision.

Every major TV maker from Samsung to LG to Sony to Panasonic promised to launch their new 3D capable TV sets in the first half of 2010; it was featured at the Consumer Electronics Show 2010 in Las Vegas. The 3D feature is hoped to help achieve new sales of TVs.

New 3D ready content is being created and presented almost every week, like the Masters golf tournament, produced by the Augusta National Golf Club. Everyone knows about James Cameron's 3D blockbuster "Avatar," which has opened the growing era for 3D TV.

Problem 1
Despite the available limited 3D content, experts agree that 3D TV is still in its infant phase. Some technical improvements on the TVs will need to be implemented in this respect. Those consumers who recently bought a new HD TV set do not need to rush to get a new 3D enabled one before everything (technology and content wise) falls into place.

Problem 2
Prices have come down dramatically on TVs. And it makes manufacturers now look for something new to offer to keep consumers paying a premium for new products. Some manufacturers started offering Internet features in their TV sets. 3D could become the next feature to boost premium sales. Watching a movie or sporting event broadcast in 3D requires viewers to have a new 3D-capable TV. Current offering on the market have hefty price tags.

The success of "Avatar" has also grabbed Hollywood's attention. Now movie studios are staring to produce new 3D movies and retrofitting older ones with 3D. Even recently released movies are getting the 3D treatment post-production, such as the new "Clash of the Titans" remake in theaters now.

New Blu-Ray players that can play 3D movies for the new 3D TVs have been offered on the market, and movie studios are promising at least 70 titles of Blu-Ray 3D movies by the end of the year. "Avatar" will be one of them.

Problem 3
Similar to what happened with HD television, sports programs in 3D should be popular with viewers. ESPN will be broadcasting some content in 3D this summer with a World Cup soccer match, not to mention the Summer X Games, NBA games, and college basketball and football in 3D. However we should remember that HDTV, though developed in the 1970s, didn't get widely popular due to cost of parts and processes until the late 1990s. People are still not buying HDTV at the rate of regular TV in the past. The emerging 3D technology is ideal for showing events, while news broadcasting will be hardly something that people would want to see in 3D.

Problem 4
The most obvious hurdle is the fact that viewers still need to wear glasses when they watch 3D TV. TV manufacturers are working on technology for no-glass 3D viewing. However, it's still years away from showing up in consumer TVs.

Simply getting people to even wear special glasses isn't the biggest problem. The real issue is that the glasses that work with the current version of "active" 3D TVs require crystal shutter glasses, which work by very quickly blocking each eye in sequence. The glasses, in addition to the liquid-crystal lenses, contain electronics and batteries, typically good for 80 or more hours that sync to the TV via an infrared or Bluetooth signal. These glasses cost about $150 a pop. And to make matters worse, glasses made for one manufacturer's TV won't work with a competitor's TV, even though it uses the same "active" 3D technology.

A more advanced version of the 3D TV technology called "passive" 3D doesn't require battery powered glasses. Viewers can wear cheap glasses that many people are already wearing in theaters for 3D movies. Instead of spending $150, these glasses cost only about $1 to $1.50 a piece. That said, the passive 3D TVs are likely to be more expensive. Exactly, how much more expensive is unclear. Some experts estimate that these TVs will be $500 to $1,000 more expensive than the active 3D TVs.

Another issue is that the "3D effect" of a 3D picture is different for different people. For example, animated films actually have less of a 3D effect because they are designed for children, whose eyes are set closer together than adults. Some TVs, such as the Samsung 3D TV available now, allows consumers to adjust the 3D-ness of the picture. Ideally, the adjustment should be made in the glasses. Among other uses for 3D technology there are 3D games. Those who have old TVs (either HD or not) should not fear that they would not be able to watch 3D films or programs on their equipment. Older TV sets without 3D feature will still show the picture in 2D as before, even if all TV channels convert to 3D format.

Problem 5

Another concern that medical experts are researching, is that watching 3D significantly increases the workload on your eyes and brain, which are not designed for 3D at all. Eyes' accommodation mechanism experiences a huge stress and some people already do get headache while watching 3D movies. It is said to depend on the distance to the screen. If you can choose a back row seat in a cinema, it is more difficult to do at home in front of your 3d TV.

14. 3D TV Industry Needs to Decide Upon Standard 3D Glasses

The 3D thing is on the rise now. Just after the movie 'Avatar' grossed in quite a few millions in the opening week (thanks in no small part to the spectacular 3D version), then new movie 'Alice in Wonderland' has surpassed it this week, again owing to the fantastic 3D effects onscreen.

Now, if 3D movies are on the rise, can 3D television be left far behind. Indeed no, as we see many TV manufacturers lining up for selling 3D TVs. It's official now- 3D Television sets have arrived. Panasonic is planning to launch a new series of 3D enabled HDTVs on Wednesday. Both Samsung and Sony are gearing up for releasing the 3D version pretty soon. Sony is set to come up with the 3D TV set in Japan in a few days. 3D Blu-ray players are arriving too, along with the 3D channels like ESPN, Discovery, DirecTV and others.

With the gaining importance of 3D television, it is still surprising to note that the big players haven't yet decided on the simplest 3D component standard: the 3D glasses. Although standards have been set in some areas (for example, any 3D blu-ray player shall work with any 3D TV), no standard has been set for the most important part of the business, the glasses.

If your 3D glasses for Sony 3D TV doesn't work with the Panasonic 3D TV of your neighbor's, then like you, many people might consider the 3D hype to be not up to the expectations and unnecessarily costly. The high-tech glasses cost $100 or more for a pair. The only way to beat this problem lies in the hands of the customers themselves. Many people who would buy a 3D TV would stick to 2D programming until glasses become cheaper and standardized among vendors.

Manufacturers are clambering over one another to bring their 3D devices to the consumer market this spring, having spent much of the year hyping up the new technology. And, while 3D Blu-ray has already been standardized, the various different technologies for 3D TV remain untamed. In answer to this, the Digital Video Broadcasting Project (DVB) has announced plans to introduce a common format; we can expect the first phase of the process to be complete within 2010.

The first phase will focus on the display side of the technology, meaning viewers will be able to use their existing receivers when Phase 1 comes into effect. Phase 2 will define compulsory capabilities for receivers, and could therefore mean viewers have to update their set-top boxes.

DVB 3D-TV will be a new standard coming partially out at end 2010 which will include techniques and procedures to send a three dimensional video signal trough actual DVB transmission standards (Cable, Terrestrial or Satellite).Currently there is a commercial requirement text for 3D TV broadcasters and Set-top box manufacturers, but no technical information is in there.

Nowadays 3D TV technology is already in his first steps regarding his standardization, now the major 3D market is in theaters and Blu-Ray Disc players with stereoscopic systems, but in near future it will be extended to diffusion, and later Free viewpoint television will come into our homes, which means the need of new coding and transmission standards.

14.1. Implementation

The implementation of first generation of DVB 3D-TV will stagger:

   * **Phase 1:** the first standard will have forward compatibility with actual HD systems with just some firmware actualization at HD systems set-top boxes and, of course, the need for 3D panels; however signaling or distribution formats should not prevent future expansion to support new 3D encoding formats. This system only works with stereoscopic Frame sequential 3D systems. Requirements for this system, which is called Frame compatible format, are included in the commercial requirements of DVB. Some broadcasters like Sky3D or Canal+3D are already using this technology, which is largely thought for Pay TV.

* Phase 2: the use of new broadcasting requirements for specific 3D streams won't be compatible with actual 3D STB, but it would be service compatible with 2D STB if no specific 3D STB is available by using Scalable Video Coding and Multiview Video Coding techniques, i.e. not having to simulcast 2D and 3D and occupying only one channel by using an unique video stream with a normal 2D basestream and a adjustable 3D depth layer. This system is called service compatible and is designed for Free-to-air group of broadcasters.

3DTV signals
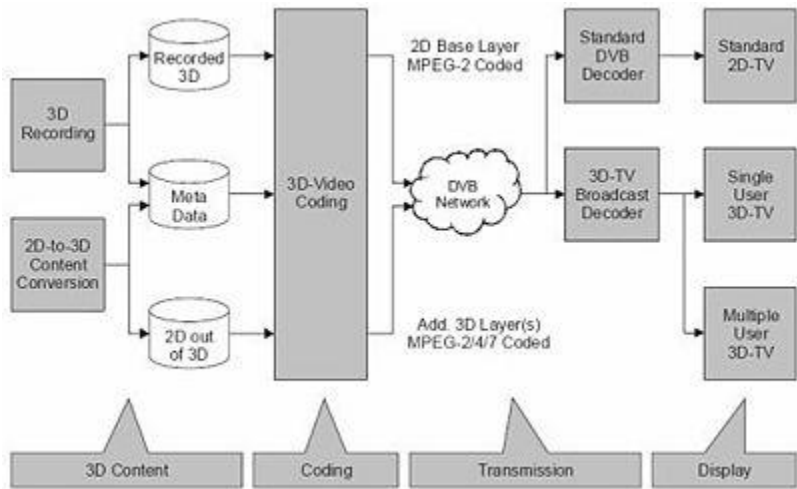
Figure 8: Diagram of a CSC or FCC 3DTV system

Matrix of signal formats for 3DTV:

Compatibility level	1st generation 3DTV	2nd generation 3DTV	3rd generation 3DTV
Level 4: **HD service compatible (CSC)**	2D HD + MVC (L,R formed by matrixing: depth info)	2D HD + MVC (Depth, occlusion and transparency data)	
Level 3: **HD Frame compatible (FCC)**	Frame compatible + MPEG resolution extension (ex. SVC)		
Level 2: **Conventional HD Frame compatible (CFC)**	L and R in same HD frame		
Level 1: **Conventional HD display compatible (CDC)**	Color anaglyph		

15. Interpretation of Market Trends
15.1. Gartner Chart and the emerging technologies

The Hype Cycle for Emerging Technologies features technologies that are the focus of attention in the IT industry because of particularly high levels of hype, or those that may not be broadly acknowledged but which we believe have the potential for significant impact. The metric is designed to provide a cross-industry perspective on the key technologies and trends developing in emerging-technology portfolios. Each of the 75 individual Hype Cycle reports provides a snapshot of a key area of IT or business and the analyst believes that senior executives, strategists, business developers and technology planners should consider these technologies when developing emerging business and technology portfolios.

During 2010, Gartner's high-impact technologies at the Peak of Inflated Expectations during 2010 include private cloud computing, augmented reality, media tablets (such as the iPad), wireless power, 3D flat-panel TVs and displays, and activity streams.

3D TV and media tablets are among the transformational technologies that Gartner predicts will hit the mainstream in less than five years. The analyst expects that user experience and interaction will figure highly in 2010 with new styles of user interaction driving new usage patterns.

Gartner is out with its 2010 hype cycle and our subject of study 3DTV,as well as 4G, activity streams and cloud computing are at the peak of inflated expectations. This can probably be interpreted as a phase of overenthusiasm and unrealistic projections.
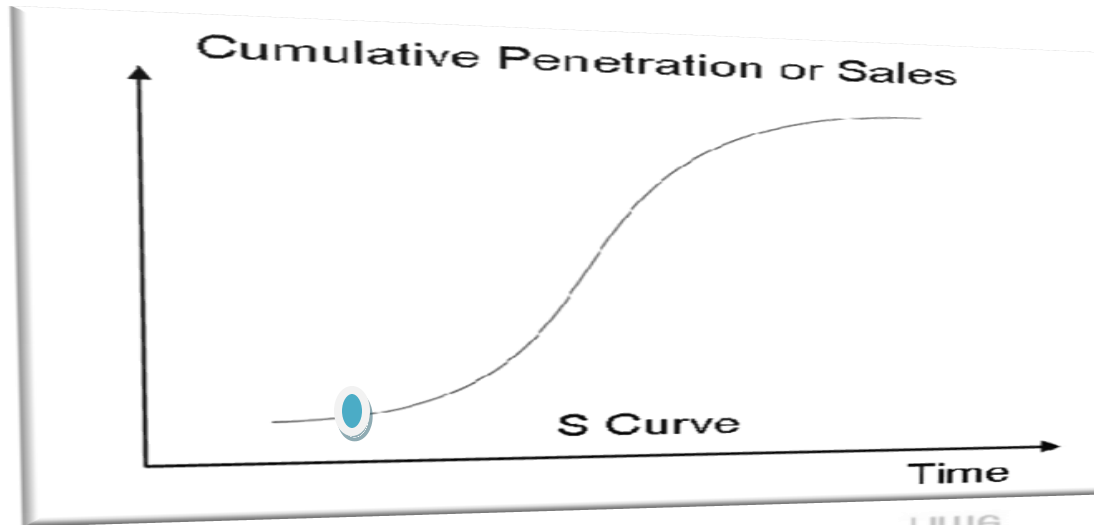
Although according to Gartner's map, it means that this technology may be on its way to mainstream, the next stop is the one of disillusionment because it might fail to live up to the consumers' expectations.

Gartner chart depicts all emerging technologies and places each one of them in its suitable phase. 3D TV is very new and it has not yet become a mainstream product.
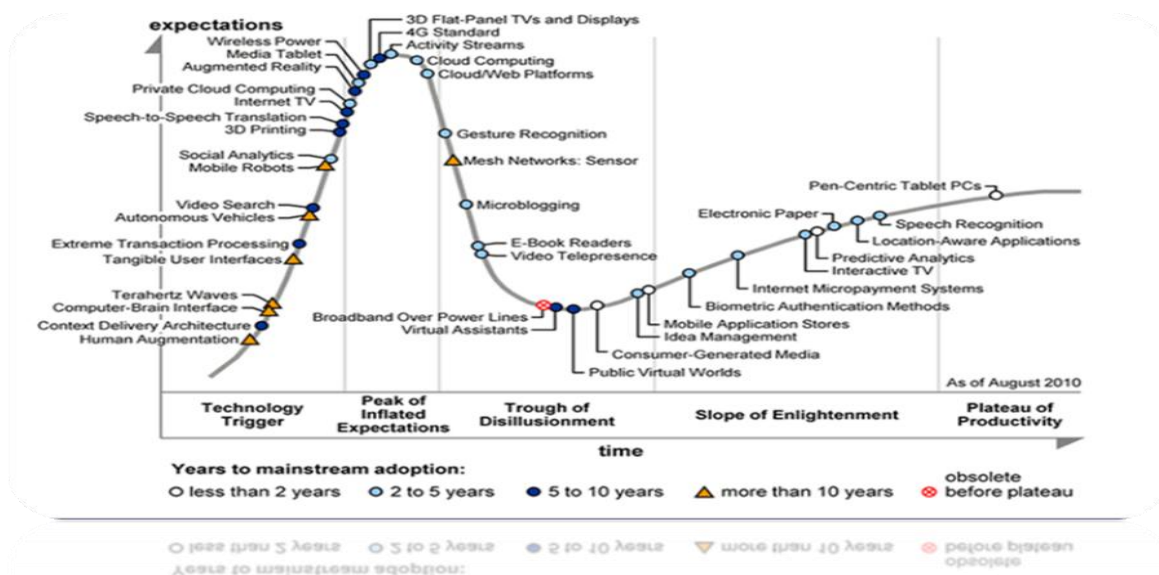
15.2. S – Curve

The 3D TV technology's position in an s-curve is at the beginning of the curve. The penetration in sales is still very low as it has not yet become a mainstream technology, so there is a long way ahead until there is an established 3D TV market.

15.3. SWOT Analysis

Strengths	Weaknesses
o **3D movies have existed for more than 50 years on the big screen** o **Inclusion of both displays and applications** o **High interest in 3D technology after the success of e.g. Avatar**	o **Not enough available market data for 3D display** o **New hardware is required for 3D** o **Switching from today 2D to 3D will be expensive** o **Viewing experience may be inconvenient**
Opportunities	**Threats**
o **3D Gaming** o **Academic as well as Professional applications** o **3D TV sport content** o **3D Advertising content** o **Adoption of 3D TV by the Adult Film Industry**	o **Pc graphic chip makers may offer the same 3D technology at a lower price** o **Long term exposure to 3D may involve health risks** o **Too few cost/benefit proofs may impact adoption** o **New better technology may emerge**

Strengths

- **3D movies have existed for more than 50 years on the big screen**

The production of 3D movies began to peter out as the studios turned to the less troublesome CinemaScope as a means of coaxing the audiences back into the cinemas. By 1955 3D was finished and the wide screen was king. The studios had their research and development departments busily trying to find ways around Fox's patented anamorphic system and thus avoid paying their exorbitant license fee, which eventually they did. And of course, Mike Todd's 'Cinerama out of one hole' Todd-AO was only months away.

3D might have been down, but it was not quite out. Several years later 3D would return - this time in widescreen, too! And some years after that a system called IMAX would be born; and when IMAX would eventually be combined with 3D we would be treated to 3D presentations that could only be described with one word: Awesome!

- **Inclusion of both displays and applications**

Advances in touch screen, gesture, and hap tic systems provide the user the ability to interact directly with displayed information. Submissions are sought which discuss advances in user interaction paradigms and advances in input devices, which improve user performance. This area further includes development and evaluation of interaction paradigms involving the impact of cross- modal display or sensing technologies. Submissions within this area are expected to explicitly demonstrate the impact of the relevant technology on user performance, enjoyment, engagement, or comfort.

• Development or evaluation of user paradigms involving touch, gesture, and hap tic input
• Cross-modal interaction (display or sensing of touch/sound/ smell with visual information)
• Usability evaluations or comparisons of display-centric input devices

- **High interest in 3D technology after the success of e.g. Avatar**

The latest *Avatar* movie directed by James Cameron has quickly earned over a billion of dollars and become one of the most popular movies in history. But, in addition to being a revolutionary movie, *Avatar* may also become a key "killer app" for the emerging stereoscopic HDTV industry.

"HDTV never had a 'killer app' and has consequently taken a decade to gain any real traction – and even then, it is been largely a result of rapidly falling prices and last year's switch to digital. *Avatar*, however, has clearly presented consumers – and the industry at large – with a compelling case for going 3D," said Alex Perilla-Gayle, director of consumer insights at Zpryme market research and consulting firm. According to Zpryme, 3D HDTV could not have a have a better killer app than *Avatar* 3D. Based on overall consumer and industry excitement, it is clear that 3D is here to stay this time around, the market research firm claims, and based on the success of *Avatar*, 3D HDTV adoption seems set to mirror, if not exceed, that of HDTV.

Weaknesses

- o **Not enough available market data and information for 3D display**

Between a sluggish economy, lack of standards and few movie offerings, the latest and greatest in television technology is likely to remain a niche product.

It is widely proven that sales on 3-D TVs have been slow so far due to a lack of consumer knowledge on the product. This has stunted sales. People don't always know what they are getting - and are anxious about putting down that much for an unproven appliance for a very few games, channels or DVDs.

- o **New hardware is required for 3D TV**

By that we mean the appropriate glasses. Only Sony, Panasonic, and Toshiba are on record saying that their models, the LX900 series (two pairs), the 50VT20/VT25 and CELL TV (number of pairs not specified), respectively, would include the necessary glasses. Sony's other 3D series aside from the LX900 will reportedly not include glasses.

Samsung has not announced the inclusion of glasses on any of its models. The company is offering a bundle deal, however; when you buy a new 3D TV and 3D Blu-ray player, you get a "starter kit" consisting of two pairs of glasses and a Blu-ray version of "Monsters vs. Aliens." Panasonic has a similar deal, albeit with a 50-inch plasma, a Blu-ray player, one pair of glasses and no movie (yet). Glasses are currently proprietary for each manufacturer, so for example if you have a Samsung 3D TV, only the new Samsung 3D glasses will work with it.

Consequently, along with the TV is raised the issue of extra cost and equipment and of course content.

- o **Switching from today 2D to 3D will be expensive**

This has to do again with equipment. New expensive TV sets, glasses etc. will make 3D TV difficult to adopt.

There has also been some confusion over whether certification in the newest HDMI standards, namely HDMI 1.4 and HDMI 1.4a, is required for cables, TVs or other AV gear to properly handle 3D. The answer according to sources we spoke with, including Sony, is "no." In short, HDMI specification is a messy business. Being HDMI 1.4 certified doesn't mean that certain features of the new specification, such as 3D, higher-than-1080p resolution and a new Ethernet channel, are necessarily included on a given piece of hardware. Our best advice is to ignore the HDMI version of a particular product and focus on actual features provided in manufacturer product information, such as the ability to handle 3D.

- o **Viewing experience may be inconvenient**

If conventional wisdom says that watching TV is bad for your eyes, watching 3D TV may be three times worse, we're beginning to discover. The truth about the 3D viewing experience is that there are a few

right angles, which offer the high quality promised. Otherwise the image is blurry and offers no entertainment.

Opportunities

- o **3D Gaming**

The runaway successes of movies such as James Cameron's *Avatar* and Disney's *UP* have not only generated a much-welcome renewed interest in cinema-going, but they will also drive 3D TV sales when they arrive on Blu-ray later in 2010. Sky is also launching the world's first 3D television station in April which will drive consumer adoption further. Just like that imaginary game of *Tetris 3D* we dreamed of the other night, the pieces are starting to fall into place.

Of all the creative industries, it is games development that is uniquely positioned to immediately do the most interesting stuff with new 3D display and glasses tech. After all, games creators have been making their games in 3D for years, but have to date only been limited by the fact that the game is viewed and played on a flat 2D monitor or television. Game developers are uniquely poised to develop content to take advantage of 3D TV. Film makers, sports broadcasters, animation studios, and just about anyone else involved in TV need to make significant investments replacing their infrastructure of cameras, editing equipment, and so on to handle 3D data.

Game developers on the other hand already have all that information readily available. In fact we spend a great deal of time trying to make 3D worlds display well on a 2D screen. To make games work with 3D TV we already have the depth information available – we just need the means to convey that data to the new TVs."

- o **Academic as well as Professional applications**

3D TV has a lot of practical uses for a lot of different people both professionally and personally. For example, the applications to diagnostic medicine are pretty obvious. After all, a two dimensional X-ray could never compare to viewing a scan of someone's innards from any angle when it comes to figuring out what's wrong with them. Three-D scans could take the guess work out of a variety of different types of surgery by allowing doctors to look at wounds, tumors, foreign objects, broken bones, and blockages before even opening a patient up. Plus, when combined with real time scanning technology that's already available, 3D TV could even allow doctors to look at the physical processes of living people in real time.

- o **3D TV sport content**

The 3D TV where everyone is putting their trust into bringing the interest in 3D-capable HDTVs to a mass level, starting with the FIFA World Cup Football Championship 2010 in South Africa that is coincidentally going to start this summer. And there is a lot of trust put in the sports programs being aired in 3D that are supposed to bring crowds of fans of different sports in front of the TV, instead of them going to the stadium.

o **3D Advertising content**

The most effective mass-market advertising format, the TV commercial yields those absolutely essential effects in today's volatile marketplace: visibility and awareness... so that you can reap the benefits of the statistic that more than 70% of all sales are initiated by the buyer. So 3D advertising is the next best thing in terms of impressing the average consumer. Two such examples are illustrated below:

Energy Drink TV Commercial
Entirely computer generated ad made for the Red Alert energy drink.
After a hard day at work, a visibly tired cartoon-cute bee flies home. It spots a can of RED ALERT which fires her back up, providing it and its friends the energy needed to party all night long.
Uptempo, high-energy, colorful, dynamic tv commercial. Special effects and high-energy dance music make it modern, attractive and engaging for the target audience.

3D Animated Television Advertising
This is an entirely computer generated ad. It is classical Christmas and winter oriented television promotional advertising.

o **Adoption of 3D TV by the Adult Film Industry**

Apart from the fact that this industry is enormous, it is believed that what the Adult Video Industry adopts as technology, it becomes a mainstream product for the public. This happened with VHS and Betamax tapes and Blu-Ray and HD DVD.

Threats

- o **Pc graphic chip makers may offer the same 3D technology at a lower price**

This phrase sums up the fact that what can be done through a TV set can easily be done through a PC but in a much lower price.

- o **Long term exposure to 3D may involve health risks**

Doctors and researchers are starting to warn viewers about the potential dangers of spending too much time in front of a 3D boob tube. Guidelines for Samsung's new line of 3D TVs warn against prolonged exposure to 3D TVs for kids (kids under 6 shouldn't watch at all), teens, pregnant women, the elderly, sleep-deprived people and anyone buzzed on alcohol.

They also point out that watching 3D programming might cause motion sickness, lingering depth perception problems, disorientation and "decreased postural stability."The guidelines suggest taking frequent 30 minute breaks from TV watching."WARNING," says the Samsung site that promotes its new line of 3D sets, "children and teenagers may be more susceptible to health issues associated with viewing in 3D and should be closely supervised when viewing these images.

"Pregnant women, the elderly, sufferers of serious medical conditions, those who are sleep deprived or under the influence of alcohol should avoid utilizing the unit's 3D functionality," it reads. While most of the warnings may be the work of overzealous lawyers, there's "a small method to the madness," says Dr. Norman Saffra, director of ophthalmology at Maimonides Medical Center.

This is especially true if you happen to have an ocular condition — such as weak eye muscles, lazy eye or the inability to see 3D. In those cases, "you're stressing the [eye] muscle system so that everything can stay in focus all the time," Saffra says. That's why some people, after taking off the 3D glasses, have horrible headaches and can be disorientated, because things are off balance because their eye muscles have been strained watching the movie or TV show.

- o **Too few cost/benefit proofs may impact adoption**

Many consumers are familiar with 3D from the theater and most understand the benefits of 3D in the home. What many consumers simply won't get behind are sets that are overpriced and then require active glasses that cost $200/pair or more adding an extra $800 or more to the cost of going 3D for a family of four.

- o **New better technology may emerge**

Before 3D TV becomes a mainstream technology, holographic TV may appear and it could make a bigger impact.

15.4. What's next for 3D TV?
As early as the end of this year in Japan, according to a report, Toshiba will release televisions capable of displaying 3D content that, unlike current models, do not require viewers to don special glasses.

The report in Japanese newspaper Yomiyuri was neither confirmed nor denied by Toshiba. Company spokesperson Yuko Sugahar said Tuesday only that Toshiba has such technology in the works.

The technology, known generically as autosterescopic 3D, was thought to be at least a few years away from commercial viability, according to industry sources CNET has spoken with, such as THX. According to the newspaper, the date could come much sooner, though it didn't provide more detail beyond saying that Toshiba will unveil three models of the television, which will cost several thousand dollars, before Christmas.

16. Will the world embrace 3D television?

There is a projection that the market for 3D TVs will reach 78.1 million units in 2015, up from an estimate 4.2 million this year. Still, there are substantial challenges that have to be overcome.

The big issues:

- **Standards**: The report notes that the Blu-Ray standard for 3D TV was set in 2009. There are a few more standards that are still being worked out.

- **Content**: Although consumers will expect quality similar to the blockbuster movie Avatar, achieving an equivalent immersive experience will depend on content availability.

- **3D Glasses**: The report notes that while TV manufacturers might throw in 1-2 pairs of 3D glasses with a TV purchase, buying additional glasses for more viewers could be expensive.

- **Meanwhile, there have been concerns raised about health hazards from watching 3D TV content, such as potential dizziness, motion sickness and disorientation.**

3D TV is a work in progress, and it will be slow to develop as a mainstream product. But there are two market segments that may adopt it quickly. The first is gaming. 3D games deliver an amazingly immersive experience. The other is the adult movie industry. Sources tell me that X-rated movie studios are the major buyer of 3D TV movie making equipment. The sad reality is that the adult industry drove the first major wave of VCR sales. It may well drive the first wave of 3D TVs, as well.

A mass adoption, however, still seems a ways off. It's just not ready for prime time. There are not a lot of 3D TV programs at present, and while there will be an increase in 3D sports and nature programs in the next 12-18 months, my sense is that 3D TV will continue to be a work in progress for the next three to four years. During that time, companies will be teaching pros how best to shoot 3D.

The technology is good now, but it will only get better. As more and more 3D content goes mainstream, so too will the adoption of 3D TV. |It is a guess that we may see it become a part of our prime time viewing habits as early as 2012, but more likely around 2013 or 2014.

Appendices

- http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/100104_3d_display_revenues_forecast_to_reach_22_billion_by_2018.asp

- http://www.mpegif.org/m4if/bod/Working%20Groups/WP_MPEG_Standards_for_3DTV.pdf

- http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/100728_3d_tv_shipments_expected_to_reach_3_4_m_in_2010_and_42_9_m_in_2014.asp

- http://www.3dtv-research.org/publicDocs/techReports08/D36.3_Public.pdf

- http://neohdtv.com/3d-tv-shipments-to-approach-50-million-in-2015-says-abi-research/

- http://www.ps3informer.com/playstation-3/news/video-games-are-key-to-success-for-3d-tv--012284.php

- http://www.practical-home-theater-guide.com/3d-tv.html

- http://www.canada.com/competition+heating+2010/2342815/story.html

- http://www.3d-display-info.com/tags/market-reports

- http://blogs.barrons.com/techtraderdaily/2010/05/25/3d-tv-isuppli-sees-potentially-big-marketbut-large-obstacles/

- http://news.cnet.com/3d-tv-faq/?tag=mncol;2n
- http://ezinearticles.com/?3D-TV-Technology-Has-Plenty-Of-Applications&id=1015137
- http://www.sid.org/conf/sid2011/call.pdf
- http://www.ibtimes.com/articles/26588/20100603/3d-television-sales-samsung-lg-panasonic.htm
- http://www.pcworld.com/article/191052/tv_industry_needs_a_standard_for_3d_glasses_now.html
- http://3danimation.e-spaces.com/tv_commercial_production.html
- http://3dvision-blog.com/the-3d-tv-channels-are-coming-when-and-what-to-expect-from-them/
- http://www.rapidtvnews.com/index.php/201010118199/3d-tv-at-peak-of-analysts-hype-cycle.html
- http://see3dtv.info/category/3d-content
- http://www.dailytech.com/Consumer+Adoption+of+3D+and+Internetenabled+TVs+Still+Slow/article20401.htm
- http://arstechnica.com/old/content/2007/01/8602.ars
- http://www.xbitlabs.com/news/multimedia/display/20100108142600_Avatar_Expected_to_Become_a_Key_Driver_for_Stereoscopic_3D.html#
- http://www.panasonic.com/3d/explore-the-technology.aspx
- http://www.sony.net/united/3D/static/technology/3dtv/
- http://www.lg.com/uk/3d/index.jsp
- http://www.pcmag.com/article2/0,2817,2366606,00.asp
- www.wikipedia.org
- http://www.jvc.eu/3d_monitor/technology/video.html
- http://www.mitsubishi-tv.com/3D.html#need
- http://www.crutchfield.com/S-WDku7YkJTPx/learn/HDTV/3D.html

- http://www.crutchfield.com/S-MIDTscvZrbr/learn/learningcenter/home/tv_glossary.html
- http://www.directv.com/DTVAPP/content/directv/what_is_directv
- http://www.cablevision.com/
- http://www.tgdaily.com/games-and-entertainment-brief/50464-directv-launches-3-more-3d-channels-while-most-broadcasters-stil
- http://www.globalsources.com/manufacturers/HD-STB.html
- http://en.wikipedia.org/wiki/3D_television
- http://www.zath.co.uk/panasonic-plasma-3dtv-technology-demo-event/
- http://www.crutchfield.com/learn/HDTV/3D.html?page=2
- http://en.wikipedia.org/wiki/3-D_film#cite_note-0
- http://www.crunchgear.com/2010/06/19/a-guide-to-3d-display-technology-its-principles-methods-and-dangers/
- http://www.techwatch.co.uk/2010/12/01/sky-to-broadcast-avatar-3d-at-christmas/
- http://www.armaghelectrical.com/blog/2010/05/how-3d-tv-actually-works/