

CTAM ADVANCED CABLE SOLUTIONS CONSORTIUM

3DTV – Things You Need To Know

September 2010



Photo courtesy of Samsung

This report is the property of CTAM, the CTAM Corporate Initiative Partner companies and their employees. The purpose of this document is to inform audiences about 3DTV.

Overview

CTAM's Advanced Cable Solutions Consortium (ACSC) is powered by corporate members committed to supporting the growth of cable's advanced products and services. Cable companies, content providers and suppliers are all working together to influence the design, development & delivery of advanced products and services.

Members of the Advanced Video Committee within the Consortium have been collaborating on this FAQ for several months. We want to thank these members for their efforts and support in gathering and developing this most informative document.

We'd also like to thank our colleagues at CableLabs and the Consumer Electronics Association for their collaboration and support.

How to Use this Document

This FAQ is intended to answer questions about 3DTV for multiple audiences who are either involved in the cable industry or are cable subscribers. It is divided into four sections.

- A. Questions and Answers for the Consumer
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CTAM and its members will provide updates to this document on a quarterly basis and post refreshed content in the Resources section of the CTAM website. (www.ctam.com)

Top Three Questions About 3DTV.

1. What is 3DTV?

Two dimensional (2D) TV – what we all grew up with, and what is likely the type of TV screen you have right now – means two dimensions: The **height** and **width** of the screen. 3DTV adds a third dimension: **depth**. The visual depth is created through the use of two camera lenses, one for each eye. The images from the two lenses have an offset, and when the brain combines them, we are seeing “in 3D.” This is known as “stereoscopy,” or “stereoscopic 3D imaging,” to mean the fusion of two slightly different views of a scene, onto each retina. By adding depth to the viewing experience, some objects seem closer to you, or farther from you. Commercially, 3DTV is term for display technologies that let home viewers experience TV programs, movies, games, and other video content in a “stereoscopic” format.



Image courtesy of Samsung

2. How many types of 3DTV content are there? How are they different?

Before a 3D image can be transmitted to the home, it needs to be encoded and compressed. Part of the compression involves a method called “spatially encoded 3D,” which juxtaposes both the left- and right-eye images onto one frame of video – or, within the same transmission space typically occupied by one (two dimensional/traditional) stream of HDTV video. The placement of the two 3D frames onto the one HD frame can be done side by side-by-side, or top to bottom, or by “checkerboard” interleaving. The juxtaposition of video streams is also discussed in terms of “panels.”

The predominant methods of spatial encoding supported in cable systems are the top-and-bottom and the side-by-side method. These are sometimes called “compatible” encoding, to differentiate from new 3D Blu-Ray systems, which require new equipment and technology. The new (2010) 3D Blu-Ray discs, for instance, won’t play in 3D on last years’ players.

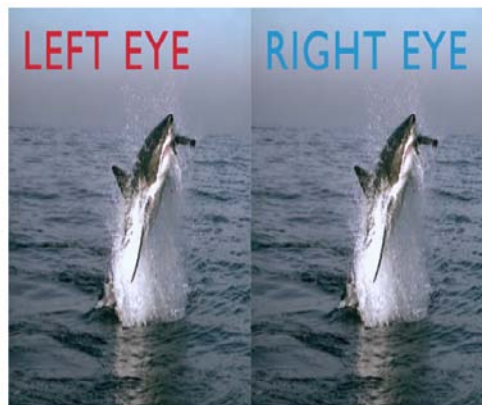
Spatial techniques like side-by-side and top/bottom encoding are intended to optimize available bandwidth, such that one 3D stream fits comfortably in the space of one 2D HD stream. But, by squeezing two images into one frame, the resolution of that frame is necessarily reduced by one-half. This isn’t overtly visible to the average viewer, partly because the brain is too busy processing the additional depth in the stream to discern the resolution reduction, and the reduction itself is half of what is already a high-definition stream.

Both spatially encoded and Blu Ray-styled 3D requires consumers to purchase a 3DTV set; neither will work on a 2D or traditional HDTV set.

Another historically important 3D content type is **anaglyph imaging**. **Anaglyph** has been around for decades, as a 3D technique that works by multiplexing the two camera images for each eye using a two-color system (usually red and cyan). This is the only approach that is compatible with both existing transmission equipment as well as existing 2D displays. Anaglyph systems use simple paper glasses that must be matched to the specific program. When viewed through the appropriate anaglyph glasses, they reveal an integrated 3D image that visually suffers from some loss of color fidelity. Check with your service provider for specifics.

3. What's the difference between 3D and HD?

High-definition television (or **HDTV**, or just **HD**) refers to video resolution that is substantially higher than traditional television systems (standard-definition, or SD TV). HD contains six times the picture resolution as standard definition TV, and as such leans heavily on digital compression techniques to send and store content.



*The side-by-side, frame compatible method.
Image courtesy of Discovery Communications*

3DTV, by contrast, is a *feature* within newer HDTV sets. It contains the mechanisms for creating the illusion of the third dimension -- depth. **3DTV** will be delivered as a new service, much like HDTV is a separate service, typically on another channel.

A. Questions and Answers for Consumers

A.1. How 3DTV Works

The new generation of 3D video technology has its origins in an image-display technique that was invented – kid you not – in the 1800s. “Stereoscopy” is a way to create the illusion of depth in an image. It mimics the way we see things in the real world by presenting slightly differing perspectives of an object to the left eye and right eye. As the brain accepts input from both eyes, it interprets depth from the relationship between the two. You’ve seen stereoscopy at work in stereogram photographs and (if you were around in the 1950s) a popular children’s toy called the View-Master. And more recently, it’s been a pretty big deal at the local movie theater.



If you're over 40, you probably played with a "View Master" when you were a kid. It's 3D. Here's the 686px-View Master as shown on Wikipedia.

Now, those same techniques are wrapped into a technology platform involving high-definition TV screens, dual-camera production approaches and battery-powered eyeglasses to create a stunning visual experience – right in your living room. 3D television, after decades of experimentation, is finally entering prime time. The key breakthrough involves a technique of exposing dual image frames – one for your right eye and one for your left – in rapid progression on specially made TV sets. In perfect (and silent) synchronization, battery-powered eyeglasses accept only the image for the intended eye. The result is the creation of depth perception – the third dimension – for a medium that historically has presented only a flat depiction of images.

At least that’s the scientific result. What will keep you transfixed is the experience it creates – more compelling and immersive than anything you’ve seen on television before. From live sports to concerts to breathtaking nature scenes, the cable industry is now making the long-sought dream of 3D television a living-room reality.

A.2. So, does 3DTV really work in the home?

Not only does it work, it makes for a spectacular viewing experience in your own home. 3D isn’t necessarily optimal for every type of TV content – we’re not convinced the world is waiting breathlessly to watch Sunday morning news shows in 3D – but for visually rich movies, sports events, nature/outdoor shows, and many TV shows, it’s a videophile’s dream come true.

A.3. So what’s to watch?

Even in these early days of 3D television development, there’s a variety of television being produced or rendered in 3D. As you might imagine, certain types of shows, like nature programs and live sports, are positively spectacular in 3D. The companies behind some of cable’s best-known national

networks, like ESPN and Discovery Communications, are launching or have launched 3D networks in 2010. Others, including cable regional sports channels, have started offering select games from the National Hockey League and Major League Baseball in 3D. The cable network TNT recently televised the first-ever NASCAR race in 3D. Also, cable On Demand services are gearing up to offer 3D movies, concerts and special events. And Hollywood movie studios are busy making 3D movies, with 70-plus titles expected to be released or in production this year. Many will show up on cable sometime after their theatrical run ends. It's best to check with your service provider for 3D TV offerings.

A.4. Why isn't everything in 3D?

Producing television and movies in 3D is expensive, because it requires special cameras (two per shot) and extra crews. Plus, venues like sports stadiums weren't designed with 3DTV production in mind, so producers have to figure out (and pay for) inventive ways to get their cameras in the right positions. With costs relatively high, television producers are carefully evaluating which shows and events are likely to work best in 3D.

A.5. How's it look?

Pretty much magnificent, we'd say. When cable companies offered special coverage of the Masters Golf Tournament in 3D in April 2010, the images were nothing less than stunning. Just imagine how the addition of 3D depth perception appeared on a large-screen, high-definition TV, with the lush colors of the Augusta National golf course in the background.

Other programs are equally dramatic. When ESPN televised games from the FIFA World Cup in 3D this summer, viewers were amazed. "I felt like I was inside the Durban soccer stadium, where Germany routed Australia, though South Africa is halfway around the world," wrote *USA Today* technology expert Edward C. Baig.

A.6. What took so long to get here?

Same thing that took so long to get a human being on the moon: an enormous engineering challenge. Stereoscopic 3D is the term for the technique of presenting two near-identical images on a screen, each intended to be seen by just one eye in order to mimic on the screen the way we see the world naturally. It's the rapid-fire switching of left and right eye images that produces the illusion of actual depth. Your battery-powered glasses do the work of synchronizing what each of your eyes sees with the signal coming from your TV. Your brain then interprets the back-and-forth flow as a single image, and, well, it looks pretty amazing. The invention of stereoscopic imagery dates back to 1838, and variations on the technology were popularized by movie theaters in the 1950s, mostly in association with "B" grade horror flicks. But only recently have video engineers hit on the right combination of signal delivery, frame juxtaposition, image resolution and synchronized viewing glasses to create lifelike 3D images on television.



A.7. Is it just like going to see a 3D movie?

The effect is similar, but there are some differences in approach. The glasses you get at the theater usually aren't battery-powered like those used for 3D television viewing. And of course, the screen's (usually) a lot bigger at the local multiplex. But the quality of 3D images is striking in both environments. And there's nothing quite like your own (3D) couch.

A.8. Do I have to tune to a new channel to watch 3DTV?

3D content navigation will vary between linear and on-demand titles – best to check your cable system's local listings. Linear 3D programming will likely be sent as a "simulcast," meaning as an additional broadcast of the same title, but in 3D.

So, in that sense, yes, the 3D content will be located on a different channel than 2D. On Demand titles available in 3D will be marked as such within the On Demand navigation environment. As the category advances, and as HDMI 1.4 cables and connectors enter the mainstream, 3D navigation will get more and more easy.

The Glasses

A.9. Let's cut to the chase: What's up with those glasses?

Ah yes: the eyewear question. Even though engineers are working on "auto-stereoscopic" 3D displays designed to work without glasses, the prevailing state-of-the-art in 3D television for now (and for years to come) will require that you wear eyeglasses to see 3D images properly. The official terminology is "active liquid crystal shutter glasses," in case you want to impress friends. Most trade people call them "active" or "shutter" glasses.



Active glasses use a shutter technique to quickly block the left eye, and then the right, in sync with the TV which itself is alternating left and right images rapidly.



The good news is they're lightweight and comfortable, fit easily over your prescription glasses, and render an almost-indescribably compelling viewing experience. The downside is they're not cheap. Some 3D television sets come with one or two pair of 3D glasses, but extra glasses can cost \$150 or so per pair. Even so, prices are likely to fall as popularity and volume rise. TV set makers are even theorizing that fashionable frames and designer styles will be available soon. You know: so we can look as good in 3D as the images we're watching.

Are the batteries rechargeable? More and more, the answer to that question will be YES. For now, best to check before you buy, as not all glasses are interchangeable with all 3DTV types.

A.10. Why do I need special glasses to view 3DTV?

The reason you need to wear glasses to watch 3D content is that a separate image needs to be sent to each eye. Your brain then correlates the two images into a single image with 3D depth. The TV will decode the 3D signal and display the left and right eye information on the TV screen as two overlapping images that look slightly out of focus when viewed without 3D glasses. Without the glasses, the image on the screen will appear doubled, distorted, and for all practical purposes, unwatchable.

A.11. Are there more than one type of glasses?

Yes. There are three: Anaglyph, passive/polarized (used predominately in movie theaters), and active/shutter (used predominately with 3DTV sets.) Currently, standards don't exist for eyewear, so manufacturers use different techniques for transmitting the 3D content over infrared (IR) to the glasses. In these early days of 3DTV, different types of eyewear can exist even within the same television brand. For that reason, glasses aren't necessarily interchangeable from one TV to the next. This means you may not be able to take your 3D glasses to your neighbor's house, as they may not work with their brand of 3DTV. The three types of glasses are described below:



Anaglyph Color - The anaglyphic method separates the stereo images by RGB (red, green, blue) colors and uses glasses with two complementary colors such as red/cyan, red/blue yellow/blue or magenta/green lenses to filter the images to the appropriate eye. For example, with red/cyan glasses, the red lens blocks the cyan image, and the cyan lens blocks the red image.

Anaglyphic 3D works by projecting two identical but slightly offset images on a screen, each image tinted with a different color.

To the naked eye, an anaglyphic image appears blurry, with distorted hues and color fringing. The glasses use color-filtering lenses to target one image to the right eye, and another to the left; the result is that each eye sees a different image, but the mind is tricked into believing it sees only one. The mind compensates for this by focusing in between the two offset images and blending them into one, which creates an illusion of depth. Anaglyph 3D is the oldest and least visually attractive of the 3D eyewear types.

Passive / Polarized - This method, used primarily in movie theaters, projects two polarized images onto the screen. The lenses in the glasses filter the left image to the left eye and the right image to the right eye. Linear polarization provides better isolation between the left and right images (less ghosting) but requires that you keep your head level with the screen. Unlike anaglyphic 3D, which can be projected from any screen, polarized 3D works only with special "silver screens," necessary to preserve the orientation of the reflected polarized light. The images are at right angles to



each other, which means when viewers tilt their heads, the 3D effect is lost. Another variation is “circular” polarization, which maintains good separation even if viewers tilt their heads -- but may allow more left-right crosstalk (ghosting) than the linear polarized glasses.

Active Shutter Glasses - With active, or “shutter” glasses, the stereo images are alternately displayed very rapidly. The shutters in the glasses receive signals from the TV to open and close the left and right eyes in synchronization. These glasses require batteries, which in many cases are rechargeable. Today, active shutter glasses are able to communicate wirelessly with the TV display, interacting with the action on the screen via infrared signals. This enables the lens on active glasses to shutter back and forth between different light filters, which produces the 3D viewing experience. Most 3DTV sets entering the market contain the IR blaster inside the bezel of the screen; very early 3D-capable sets use an external IR blaster.

A.12. Can I use my glasses at the theater?

Probably not, and especially in the first wave of 3DTV (2010). All 3DTVs on the market that support frame compatible delivery formats use active/shutter glasses; most 3D theaters in the U.S. are equipped for passive glasses. However, there is every likelihood that 3DTVs using passive glasses will enter the U.S. retail market – and some PC monitors and commercial products already use passive glasses. These will work in certain theaters, depending on the monitor and theater type.

As discussed earlier, there are no current standards for the glasses today and therefore manufacturers are using different technologies in the glasses. When purchasing a 3DTV, be sure to purchase glasses that are guaranteed to work with the specific manufacturer’s TV.



A.13. Will my glasses work at other people’s homes watching 3DTV?

It depends on the manufacturer of your 3DTV and glasses, and that at your 3D viewing destination. In many instances, different technologies are used in manufacturing the glasses, which would make them incompatible.

A.14. Will there come a time when we won’t need glasses to watch 3D?

Some TV manufacturers are experimenting with “auto-stereoscopic” technology, designed specifically to allow you to see 3D content without the glasses. This technology is in the early stages, and has some limitations – today, the viewing experience is not the same as with true 3D, with the glasses. However, the technology continues to evolve and could one day provide the same quality. Each year, we see examples of auto stereoscopic TVs at the Consumer Electronics Show, and so far, consensus is “not ready for prime time” – at least not for the big screen in the home. Progress in auto-stereoscopic 3D will likely show up on smaller screens (e.g. personal devices) first.

A.15. My 3DTV didn't come with glasses. Where can I buy them and how do I know which to buy?

Some 3D sets will come with glasses; others do not. Best to research your retailer or the manufacturer of the 3DTV to determine availability and pricing. As mentioned, 3D glasses are not universal and may not work with another manufacturer's TV. There are online sources for 3DTV glasses, but do the research on exactly what type will work with your set.

A.16. I need more than 1 or 2 pairs of glasses. Do I have to buy the expensive ones from the manufacturer or can I buy cheaper ones, say from EBAY or a 3rd party distributor of 3D glasses?

Again – check the documentation that came with your 3DTV, and/or contact the retailer, because 3D glasses are not yet universal, and may not work with another manufacturer's TV. There are online sources for 3DTV glasses but you must know exactly what type will work with your set.

3DTVs/Cable Equipment/Peripheral Devices and Cables

A.17. Will I have to buy a new TV set?

Yes. Normal TV sets lack the ability to render 3D images for two main reasons. First, a 3DTV set has to have built-in hardware that can send information to the 3D viewing glasses. Second, 3D signals demand faster presentation of image frames – 120 per second – than normal TVs can accommodate. That's why manufacturers like LG, Panasonic, Samsung, Sony, Toshiba, Vizio and others have come out with new lines of 3DTV sets you can find at major electronics stores and websites.

Image courtesy of Cisco



A.18. Are all the new HDTVs 3D-capable?

No. While most major consumer electronics manufacturers are building 3DTV capabilities into their HDTV lines, not all new HDTVs are 3D-capable.

A.19. Can I watch 3D content on my computer?

Yes. You will need a 3D capable computer monitor and associated eyewear – a full 3D package, which may also come with a video card. Some new PCs and laptops introduced in 2010 already come with 3D capabilities. Meanwhile, more and more 3D content is available via the Internet, and especially on YouTube, which has a method to upload a “double wide” (two full frames packed side-by-side) stream. That, in turn, includes a special metadata tag to play out in the 3D format supported on the computer monitor. As of early 2010, YouTube housed over 10,000 3D clips. Find it by entering the YouTube metadata tag “YT3D:enable=true” in a browser search window, which will activate its 3D player.

A.20. Do I need a new Blu-ray player?

Probably. Most 3D enthusiasts will need a new 3D-capable Blu-ray player to watch newly formatted 3D Blu-ray discs. However, owners of Sony PS3 video game systems, which include Blu-ray capability, should be able to upgrade their existing hardware to accommodate 3D Blu-ray movies.

A.21. Will a 3DTV set let me watch normal television, too?

Yes. All 3DTVs display the normal two-dimensional television channels and programs you already receive. And you don't have to wear special glasses to watch them.

A.22. What does 3D look like on a traditional HDTV?

Generally, for cable systems, 3D service provisioning should prevent 2D subscribers from stumbling upon 3D programs they are not technically able to view. However, viewing a 3D image on an 2D HDTV screen without eyewear will look blurry, or ghosted, or visually juxtaposed. Some titles will be transmitted in 2D and in 3D – meaning that viewers who don't want to watch in 3D will have a 2D option. In the early days of 3D, the methods to switch back and forth won't be automatic. A physical toggle on the remote control will be necessary to switch back and forth between the two modes.

A.23. What about my digital cable box? Do I need a new one?

Perhaps. Sorry for the wiggly answer, but it really does depend. In some cases, you won't need a new set-top; as the technology matures, you may *want* one, to keep current with improved 3D encoding methods. Generally speaking, though, modern digital cable receivers – the boxes that let you tune to your favorite cable channels, watch HD shows and select On Demand movies – already have what it takes to relay 3D signals to your 3D television set. So if you have HD cable you're likely to have what you need already. And if you're upgrading to digital cable for the first time (congrats on that, by the way), your cable company will supply you with a new set-top box that can accommodate 3D.

Note that set-top manufacturers are making "3D-capable" set-tops, which will seamlessly switch between 2D and 3D channels.

A.24. I have an older HD set-top. Can I still watch 3DTV?

Probably. As long as your set-top is HD capable, and your TV is 3D-capable, you will be able to view 3DTV. It's best to check with your service provider.

A.25. Can I record 3DTV on my DVR so I can watch it later?

Yes. To the DVR, 3D content looks like any other HDTV recorded content.

Image Courtesy of Motorola



A.26. How much space will 3D content consume on my DVR?

Not more than any other HD content. 3D content is sent over cable systems using a technique called “frame compatibility,” meaning the two left-eye and right-eye frames representing the 3D image are lowered in resolution, so as to compatibly fit into one frame of HD video.

A.27. Will my universal remote work with the new 3DTV?

Given the multiple interpretations of what constitutes a “universal remote,” it’s best to check the printed or online documentation for 3D-mode capabilities.

A.28. Will 3D content in the home increase my cable/satellite bill?

Too soon to tell. For On Demand titles, a premium is likely. After all, viewing a 3D title at the movies costs more and is priced higher than the same title in 2D. The same logic prevails in residential 3DTV. Best to check with your service provider.

A.29. I use an A/V Receiver with an HDMI port that acts as a switch to my home theater components and to enhance the sound. Will I need a new one?

It’s likely. Most traditional A/V Receivers aren’t HDMI 1.4-compatible, which means you won’t have the ability to automatically switch between 2D TV and 3DTV. To ensure that your system will eventually switch between the two modes automatically, you will probably need to replace your older A/V receiver. Also note that 3D only works with HDMI cables, not component connections, which are the predominant cable of choice in most home theaters today.

A.30. Can I use my existing cables?

That depends on your cables, but probably not. Most TV makers specify HDMI version 1.4 connectors for players/source material and 3DTVs in order to receive full 1080p resolution in both eyes. 3DTVs and Blu-Ray players will increasingly support HDMI 1.4.

A.31. What is an HDMI cable and why do I need it?

HDMI is part wire, part connector, and part protocol. It’s the digital successor to the component and S-video connectors of the analog world, and it’s different, because it handles both audio and video in one connector. The protocol part of HDMI defines how data talks across the pins of the connector, over the wire, to the other connector.



HDMI is the predominant way to connect HDTVs to new set-tops and Blu-Ray players. Its latest version, 1.4, enables automatic switching between 2D and 3D modes.

In February 2010, a new version of HDMI – HDMI 1.4 – hit the scene. Mostly, it adds a way for a 3DTV to identify itself as such, to a set-top or DVD player. All prior HDMI versions are bi-directional, and most include a mechanism called “CEC,” for “Consumer Electronics Control.” It’s the behind-the-scenes way to push one button – say, “play,” – on the DVD remote, which then powers up the player, switches the display input and starts the movie.

What had been missing was a way for the display to identify itself – for instance, “hi, I’m a 1080p display; I can present 3D in the following ways.” HDMI 1.4a (released in March 2010) will correct that, making it an action that occurs automatically and in the background.

Watching 3DTV

A.32. Why do some people get headaches from watching 3D?

In our normal vision system, there are 2 different muscle groups that control our eyes’ ability to focus on objects with different depths.

The first muscle group squeezes, or contracts, the lens of the eye to focus on things that are close, and relaxes that motion when things are at a distance. In 3D circles, that’s called the “accommodation” element. The other muscle group squeezes or contracts the angle of your eyeball to converge your eyes on something close. You relax those muscles to see things at a distance. This is called the “vergence” element. We use these two groups of muscles together – contract and relax at the same time. That’s the natural muscle control we learn from infancy.

With 3D, only the vergence muscles are used to perceive depth. Our focus remains fixed on the distance of the screen. Some people have difficulty separating the two muscle groups. Some people see double images with glasses. Doctors can give a test to determine if this is the case.

A.33. Can I lay down and watch 3DTV?

Generally speaking, if you tilt your head, the images will appear misaligned. The eyes and brain can accommodate a certain range of motion, but the depth imagery can seem to completely disappear if you tilt your head 90 degrees. The greater the angle, the larger of an issue this becomes.

A.34. Don’t you have to sit far away from the TV to safely watch 3DTV?

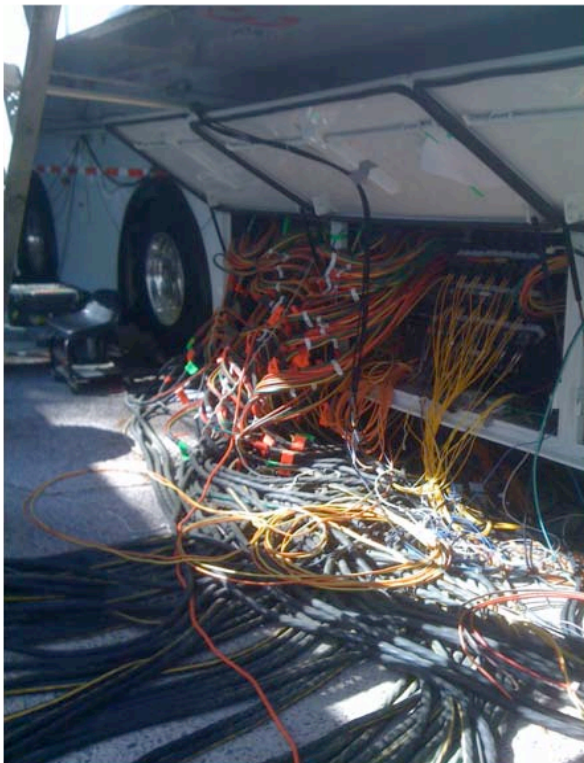
Different 3DTV manufacturers have different recommendations on how far away someone should sit while watching 3DTV in the home. Best to check the documentation that came with your 3DTV.

B. FAQ for Programmers / Content Owners

B.1. How is 3D content filmed?

Short answer? With two cameras, instead of just one: One for each eye.

Filming 3D typically requires a “stereographer,” different /modified production trucks, and precise camera calibration. It’s increasingly possible to shoot 3D content in a renovated, 3D truck, as well.



In April of 2010, Comcast used 12 cameras and a whole lot of optical fiber to transmit the Masters Golf Tournament in 3D. Image courtesy of Comcast.

Also relevant is the type of movie. “*Coraline*,” for instance, was shot in digital, over 53 stages, simultaneously. Other production necessities: Eight camera teams, a motion control programmer, a camera assistant and a lighting assistant. The talent – seven-inch puppets – were frozen with every single frame, and then manually moved to their next position. The 3D imagery was captured using a single camera taking two separate pictures: Right eye, move camera, left eye.

The National Geographic title “*Sea Monsters*” used two side-by-side cameras for live action. Hardest part about mixing computer graphics with live action? Placement of the object (a dinosaur, in his case) into the photographic environment. “We had to get it walking on the ground ... it’s tricky, to avoid its foot sinking into the ground, or floating above it.”

When shooting the NBC show “*Chuck*,” which aired in anaglyph 3D the night after the Super Bowl, the stereo focal point, and the point of convergence. The stereoscopic view was created with a faint yellow fringe on the deeper objects. Those who watched in 3D saw fairly good depth, but viewing without glasses also produced a satisfactory experience.

B.2. Can 2D content be converted to 3D content?

Yes. There are two methods – one very high quality, but slower and more expensive to accomplish; one much faster and less expensive, but lower quality.

The first type carefully converts the video on a frame-by-frame basis. For that reason, it’s a very expensive process, with impressive results -- often indistinguishable from true 3D. One example of this technique works for computer generated imagery (CGI) and involves locating the original masters, regenerating the content into two viewpoints, then re-rendering the content as 3D. Examples of this technique include the *Toy Story 1* and *Toy Story 2* 3D conversions.

Another variant of the frame-by-frame process uses the footage captured with a 2D camera, which is then analyzed by 3D conversion artists to identify the picture elements that are closer, versus farther away.

The artist literally creates the separate left and right eye views from the single frame. *Alice and Wonderland* and *Clash of the Titans* are two recent examples that used this technique.

The second process for 2D to 3D conversions uses an automated processing device, which attempts to make real-time judgment decisions about which picture elements are close or far. In that sense, it is algorithmically simulated 3D. For instance, the bottom of the screen is typically ground, and as such should be closer than the top of the screen, where the sky is. Depth of field can also be aided by motion – relative to each other, objects that are farther away move more slowly than objects that are closer.

Automated 3D conversion is more cost effective over frame-by-frame approaches, but, generally speaking, the results are often visually disappointing. Good in the short term, disturbing over long-term exposures. It tends to work best on animated material. Some 3DTVs will include a built-in 3D conversion feature, to simulate 3D on 2D content – not unlike a mono source can be manipulated to simulate stereo sound.

Note that several 2010 3DTV models, and an increasing number of 3DTV sets going forward, will include automatic 2D to 3D conversion mechanisms.



Producing content in 3D involves the use of cameras with dual lenses – one for each eye. They're quite a bit heavier than traditional digital cameras.

B.3. How much 3D content is currently available?

A few web resources exist that provide 3D content availability. One is www.3dmovielist.com, which lists over 300 3D movies and short programs. Also, for 3D games, lists exist on www.nvidia.com. More and more 3D content is being developed and as the production costs fall, we anticipate 3D films and programming will increase.

B.4. What's the best type of content to watch in 3D?

It's still very early in the evolution of 3D content, especially for the home. Early indications are that sports, nature programming, and concerts format well for 3DTV – but, it's too soon to discern any real success patterns.

B.5. How will I know a movie or show is available in 3D on my TV?

A 3D indicator will be displayed in the description of the content and on the program guide.

B.6. Which studios are planning to offer 3DTV?

The volume of 3D material coming out of movie studios is on a dramatic rise – all of the major studios are producing in 3D. For listings, check individual studio web sites or www.3dmovielist.com, or www.nvidia.com.

B.7. Which TV networks and content providers are planning to offer 3DTV?

To date, Discovery Communications, TNT and ESPN have announced or have launched the delivery of 3D content in 2010. Discovery Communications has announced plans to develop a 3D network in joint venture with Sony and Imax. Since 3D in the home is still in the early stages of deployment, we expect more cable content providers will be announcing 3D programming. Most cable providers are offering 3D movies via their On Demand service.

B.8. Does the type of content matter? For example, does 3D sports content look better on some TVs than others? Is a certain 3DTV set better for kids content?

Too soon to say. As long as the production quality of the 3D programming is of a high quality, most content can look good in 3D.

B.9. Does it cost more to film/create 3D content than HD?

Yes – today it does cost more to create 3D programming. 3D requires additional cameras, slower transitions in filming, etc. Like all technology though, as 3D gains momentum, the production costs will decline over time.

B.10. Will movies filmed in 3D also be filmed in 2D?

Often, but not always. Some films are released in both 2D and 3D; others were specifically created for 3D only.

FAQ for Cable MSOs / Distributors

C.1. Will 3D content take up more bandwidth?

The frame-compatible 3D mode was designed to work within the bandwidth confines of an HD signal, so in theory, 3D imagery delivered over cable uses no more bandwidth than a 2D HD signal. In reality, service providers will likely allocate additional bits to a 3D signal to ensure a premium viewing experience.



C.2. How do we tag 3D content in the program guide?

Each cable provider is using **3D** or **3DTV** terms to identify 3D content in the program guide.

C.3. Do we need new equipment at the headend or in our transport plant to deliver 3DTV content?

No new equipment is required at the headend to deliver 3D content when using the frame compatible method. Some updates may be required for certain equipment to optimize the user experience.

C.4. Which set-tops currently do not support 3DTV?

Because each service provider may make different choices for deployment of 3DTV, no common list exists – so it's best to check with your local cable company to determine if it will be necessary to use certain set-tops for 3DTV viewing. Newer models are constantly in development, which will further optimize the 3D viewing experience for consumers.

C.5. What's the roadmap for 3DTVs in the U.S.?

Most of the major TV manufacturers have plans to deliver 3D TVs well in time for the 2010 holiday buying season. Some will market 3D heavily; others will focus on 3D as a feature set of their HDTV product lines.

C.6. How much 3D content is required to drive the revenue for the service provider?

Unknown. Until the basics of 3D service offerings are clarified – linear, on-demand, both – it's not possible to answer in anything more than guesses. In terms of “educated guesses,” though, it bears noting that theatrical 3D titles earn two to six times more than their 2D counterparts.

C.7. Is there going to be collaboration between cable and the CE manufacturers to promote 3DTV?

The frame compatible method represents an early point of collaboration amongst the players in the 3D eco-system – originally, for instance, studios producing in 3D had only targeted Blu-Ray players for in-home 3D consumption. The inclusion of the frame compatible method is what makes 3D content a practical reality in the home, in addition to Blu-Ray content. Each service provider may make independent business decisions about any cross-promotion opportunity with TV makers.