

DEFINING HIGH DEFINITION

BY JEFF MILLER

As trends and technologies come and go, it seems like there are times when you just can't get through the day without hearing a particularly 'in' phenomenon mentioned. When it comes to Southern California architecture and lifestyle lately, the hot ticket is 'Tuscan.' Everywhere you go it's Tuscan villa, Tuscan influence, Tuscan floorcoverings, even Tuscan pizza. When it comes to video systems, the buzzword for today is 'High Definition.' Okay, that's two words, but who's counting? In nearly every meeting we have with a church about an upcoming project, high definition video is mentioned at some point. If you attended the recent NAB (National Association of Broadcasters) convention in Las Vegas, you couldn't turn around without being assaulted by the latest in an HD something-or-other. However I must admit to wondering—what exactly makes HD high definition, and what do people mean when they use the term?

A couple of disclaimers up front before we dive in—yes the fine print is here. We're going to skip or mention only briefly HD formats that are chiefly intended for use within the film production industry rather than the video or television broadcast fields. Also, there is no way to cover this subject in depth in a single article, so don't be too disappointed if something you really wanted to know about isn't in here. If I left something out, email it to me and hopefully it can show up in a future article. Finally, the HD product landscape is changing so rapidly that some of the specifications listed later may not be completely current by the time you read this.



Let's start by looking at the basics of high definition as it relates to standards for broadcast television. HD actually started as an analog format in Japan back in the mid 1980s but never really penetrated the consumer market due to high costs and major technical hurdles. At that time HD was not introduced to the U.S. marketplace due to its lack of success overseas. When the FCC mandated that analog television broadcasting be eliminated and replaced with digital broadcast signals, a new push towards a higher resolution signal was generated. In the new ATSC standards list for digital television broadcasting, 18 different video formats are considered valid for use in the digital broadcast environment, comprised of both SD (standard definition) and HD (high definition) formats.

Standard definition (SDTV) digital broadcasting mimics the NTSC broadcast signal we're used to seeing, but using a digital transmission signal. The NTSC video standard that has been used for the last 50 years has an effective viewing area of 640 x 480 pixels, which is the same for SDTV. Any video signal with a resolution greater than that of SDTV can technically be called HD, which is a large part of the reason the HD world can be so confusing.

High Definition can mean very different things to different people. Many of our church clients think it simply means a picture with a 16:9 aspect ratio rather than 4:3. While all HDTV formats are indeed 16:9, that alone does not necessarily mean a picture is HD. Manufacturers proclaim that their products are High Definition, but that term does not tell you what the resolution of the device is, what other HD products it will talk to, what editing formats it will work with, or what the potential pitfalls are.

The two basic forms of HDTV used in broadcast television today are known as 1080i and 720p. Within each of these two formats are several variations based on the frame rate of the video stream. Some options for each include 30fps (frames per second), 60fps, and 59.97fps. 24fps is also available and is the same frame rate used for film production. However, 24fps does not work well for images involving fast motion (particularly sports) due to the low frame rate.

1080i

1080i signals are comprised of a pixel matrix containing 1,920 vertical rows by 1,080 horizontal rows of dots, or pixels. This equates to 2,073,600 pixels in the image you see. Standard definition video has a total of 307,200 pixels in the picture area which means 1080i has about 7 times as much pixel density per image, which is why HD images can look so clear.

The 'i' in 1080i stands for 'interlaced.' Interlacing is a technique wherein the picture you see is drawn in two steps. Every other horizontal line is drawn (odd lines) and then the 'engine' of the display goes back and draws the in-between (even) lines. The potential drawback to this method is that slight variations in the two drawing fields leads to some 'smear' in the image. At the same time, the higher drawing rate (2x per image rather than once) helps to make fast motion clearer.

720p

720p signals contain 1,280 vertical rows by 720 horizontal rows for a total of 921,600 pixels. The big difference with this format is indicated by the little ‘p’ in its name. The ‘p’ stands for ‘progressive scan.’ This means that instead of drawing the image in two steps, as in interlaced video, a progressive scan system draws all of the lines in order in one pass across the viewing area. This allows for less smearing of boundary lines in a static image and greater accuracy in placing the image lines in their correct relationship. The tradeoff being that images containing fast motion may be choppy in motion compared with interlaced video at frame rates of 30fps. As storage capacities and bandwidth availabilities increase, progressive video at 60fps may resolve the motion issue for sports production in this format.

This leads us to the issue of storage formats. If you’re capturing all of this information, how do you record, edit, and store it in a format that will accommodate the significantly higher amounts of information involved? With the exception of 1080i and 720p uncompressed signals, all of the popular storage and distribution formats on the market today incorporate some type of compression scheme to reduce the amount of bandwidth required by the higher resolution signals. See chart for a quick comparison of some of the popular formats and the bandwidths they require.

Format	Resolution	Scanning	Total # of Pixels	Compression	Bandwidth Required (Dependent on frame rate)
DVD	640 x 480	I or p	307,200	Yes	4-10 Mbps
1080i	1,920 x 1,080i	Interlaced	2,073,600	No	795-1,485 Mbps
720p	1,280 x 720p	Progressive	921,600	No	354-1,105 Mbps
HDV	1,440 x 1080i	Interlaced	1,555,200	Yes	19-25 Mbps
DNxHD	1,920 x 1,080i	Interlaced	2,073,600	Yes (lossless)	121-220 Mbps
DNxHD	1,280 x 720p	Progressive	921,600	Yes (lossless)	58-220 Mbps
DVCPRO HD	1,920 x 1,080i	Interlaced	2,073,600	Yes	50-100 Mbps
DVCPRO HD	1,280 x 720p	Progressive	921,600	Yes	50-100 Mbps
HDCAM	1,920 x 1080i	Interlaced	2,073,600	Yes	70-140 Mbps

Note: Mbps is MegaBITS per second, not MegaBYTES (MB) per second

A large number of the HD capable storage formats currently available record to tape of some type. In fact, many of these are based on tape formats you may be using now. DVHS, HDCAM, DVCPRO HD, D5-HD, and HDV are all high definition formats that can be put on tape. Where they differ is in areas like the amount and type of compression involved, which versions of 1080i and/or 720p they will support, and sampling schemes. Most of the compression schemes used by these units are some variation of MPEG-2 or MPEG-4. A brief look at each is in order.

DHVS is based on the familiar VHS format. Other than a few products, mostly in the home theater market, DVHS has not been very popular.

HDV is based on the DV video format, but with enhancements to work for high definition resolutions. HDV uses both an MPEG-2 compression algorithm and a reduction in resolution to reduce the bitstream size. Some HDV products may use SD color space definitions rather than the HD definitions, which could create some issues in certain production environments. A large number of manufacturers are supporting this format, and many of the products are quite affordable.

HDCAM is based on the BetaCam tape format. Like HDV it uses both compression and a resolution reduction. For HDV and HDCAM, 1080i is usually 1,440 x 1080 pixels. Some HDCAM units are now available that use the full 1,920 x 1,080 resolution (HDCAM SR).

DVCPRO HD is derived from DVC-PRO, using the same tape shell. This format has received a lot of acceptance in the broadcast industry due to the fact that most of the decks can handle both 720p and 1080i at full resolution, and because the data format is supported by many popular editing systems such as Final Cut ProHD.

D5-HD is a high-end format based on D5 used mostly by broadcast stations and those with large budgets. It is primarily used for mastering of network television programs in High Definition.

A current trend in the industry, made possible largely by the various compressed formats, is towards tapeless storage. Decks and cameras are now available that store their video on memory cards (P2), optical disks (XDCAM), or hard drives rather than tape. Some of these units format the data in HDV or other formats that are also available in tape-based units, while other units use formats designed specifically for non-linear editing environments. Most HD editing happens in a computer-based NLE (non-linear editing) environment and if the data is already stored on hard disk or in memory, it is quite simple to access the data for editing.

DNxHD is an example of one of the proprietary video encoding formats used by edit system manufacturers. This is the format used by Avid for their HD edit workstations and Unity storage network. It is one of a new generation of compression codecs that is advertised as being 'lossless.' A lossless compression scheme is one where the decompressed output is mathematically identical to the original bitstream. Most compression schemes, including those used in all of the tape-based systems, are 'lossy.' This means that while the video playback *looks* nearly identical to the eye when compared to the original signal, mathematically the two bitstreams are not identical.

Once you've selected recording and editing systems that can all talk the same versions of high definition video, you run headlong into the question of distribution. If you're producing content for use during a service you can simply play it back from one of your HD decks, a media server, or your editing system. However, your projection system will need to be able to reproduce the resolution of your HD content. Otherwise it will get scaled down to the resolution of your projection system and you will lose some of the picture quality you worked

so hard to achieve. A few projectors are now available that have native resolutions of 1,920 x 1,080 and will handle 720p or 1080i content, but most video projectors are still natively 1,024 x 768 or lower.

If you want to distribute your HD content in a form your congregation can take home with them you don't have a lot of options currently. DVD is only capable of SD resolution and does not have the storage capacity for HD video. Not many households own a DVHS player. Two proposed formats have been competing for the past couple of years to become the high definition DVD format, Blu-Ray and HD DVD, but the manufacturers involved have just agreed to merge them into a single format and avoid a re-run of the VHS/Beta war. What *is* available now are the data storage schemes that have been approved for use with HD disk technologies. MPEG-2, MPEG-4, and VC-9 (the Windows Media Player 9 codec) are the approved data formats for HD video on disk. This means that you can create HD files that can be downloaded from the church's website, or burned to a data DVD, and played back on a home computer or media server.

As you consider what video technologies will best support the ministries of your congregation in the coming years, I hope you have a better idea of what some of the possibilities and challenges of high definition video are. Assembling a high definition video system can easily become a complex and costly endeavor and it is important to ensure that the equipment you purchase will adequately support the needs of the ministries it will serve.

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