

The New 3G 1080p Production Standard

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Until recently, producers had to accept compromises when selecting between the many HD production standards in use today. Data rate limitations forced tradeoffs between image detail and motion fidelity, mixing different signal formats in a production caused substantial degradation, compromising scanning methods used to conserve valuable bandwidth created serious artifacts, and the lack of a clearly superior HD production standard meant that equipment manufacturers, producers and broadcasters all adopted different standards based on their specific priorities. The lack of a quality/value leader created great uncertainty in the industry and hindered the development of a next-generation production infrastructure.

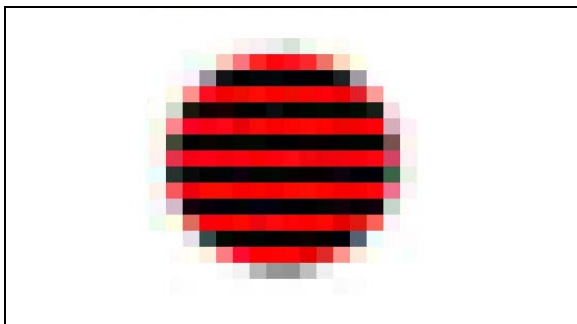
The new 3G 1080p production standard has finally ended this impasse. It's so clearly superior to all prior standards that it has been enthusiastically received and is becoming a de-facto universal standard. Its high data rate offers unprecedented image quality and allows different image formats to be freely intermixed without degradation for the first time. It's progressive image structure preserves motion integrity in critical applications. And because of 3G's nearly universal adoption in the industry, it offers tremendous value and security to those who leverage the emerging next-generation 3G infrastructure.

Progressive vs. Interlaced Scanning

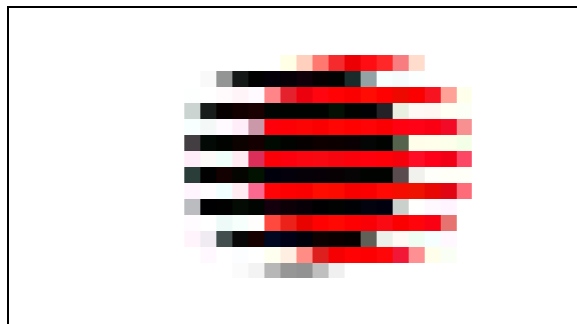
At Broadcast Pix, we have always felt that progressive-scan image formats are the optimum way to process and display moving images. 'Progressive' transmission and display means that all the scan lines and pixels are sampled for every frame. The alternative, 'interlaced' scanning, only transmits or displays half the lines and pixels during the same period. While it allows lower data rates, the temporal sampling creates significant video artifacts, such as ghosting or blockiness, especially on fast-moving objects and fine textures (like bricks in walls, waves on the water and tweed jacket patterns). With special effects processes that manipulate image size and position, interlaced signals introduce unacceptable image distortion. Because of these limitations, the 720p progressive format has been the obvious choice for programs where image clarity and motion rendition is critical, such as sports events.

Broadcast Pix switchers, even standard-definition, handle all processing in progressive form using the 576p/486p standards. This results in the cleanest, clearest possible images and effects.

Why progressive systems are better than interlaced



This is what a circle looks like to a video camera. Interlaced systems sample alternating scan lines 1/60th of a second apart: (For clarity, the different fields are illustrated in red and black respectively)



If the circle is moving, interlaced system will display the timing difference between the fields as a spatial difference representing the circle's motion over that 1/60 of a second. These kinds of artifacts plague everything that involves a spatial change, such as DVE effects and even wipes.

The Constraints of the Present

Today's 1080i and 720p HD standards are both interconnected in television facilities with single coax serial interfaces operating at 1.5 Gb/s. The 1080i interlaced format has 1920 pixels by 1080 lines occurring at 30 (actually 29.97 for television transmission-related applications) frames per second whereas the 720p has 1280 pixels by 720 lines at 60 (59.94) frames per second. Note that the lower pixel resolution, but higher frame rate trade-off for 720p results from the 1.5Gb/s data rate constraint. Conversely, for 1080i, higher resolution is achieved at the expense of a lower frame rate.

3G 1080p - The Future of Television

Enter the computer industry to the rescue: New high-speed electronic technology originally developed to support faster data processing and computer-game performance has resulted in high-performance ASICs, ASSPs and FPGAs with sharper, more precise state changes, less timing jitter, better signal parity checking and superior signal decoding to provide higher data rates over longer cable lengths and faster signal processing.

When incorporated into video circuits, these components allow twice as much data – 3 Gb/s – to be manipulated and transmitted in real-time. And when these circuits are combined with new advanced high-resolution imaging chips and display screens, it is now possible to eliminate a trade-off and support both higher resolution and frame rate with 1920x1080 pixel images, processing and displaying pictures at 60 frames per second. The new transmission standard that has been developed around this new technology is called '3G' and the progressive 1920x1080 image format is called '1080p'. 3G-HD, (or SMPTE 424M,) is simply, the transmission of full 1080p/50 and 1080p/60 uncompressed HDTV over a single coax cable at 2.97 Gb/s.

But from the user's point of view, the big change is in the pictures: The film-like images are stunning.

Superior Picture Quality

3G's 3 Gigabits/second data rate is twice the rate of conventional HD and supports an image size of 2,073,600 pixels – transmitted every 1/50 or 1/60 of a second (depending on the country). 720p only supports 921,600 pixels. 1080i can only transmit 1,036,800 pixels every 1/50 or 1/60 of a second.

The 3G signal is transmitted over a single standard coaxial cable using the recent SMPTE 424M Standard. This makes it very easy to update existing infrastructures. Previous attempts to achieve this performance involved clumsy dual cabling arrangements ('Dual Link') and buffering delays to equalize transmission differences. 3G eliminates all these hassles.

Highest Multiple Standards Production Performance

In practice, current productions often need to incorporate media created in different production formats, either because source materials are only available in a particular format or because the finished program needs to be available in multiple standards. But video sequences mastered in 1080i do not accept 720p footage very gracefully because the limitations of an interlaced signal are merely superimposed onto the lower-resolution 720p image. Similarly, incorporating 1080i footage into a 720p program preserves the interlacing artifacts while reducing the resolution to the 720p level.

The solution is to use 3Gb/s 1080p for processing and mastering. 3G offers the highest-possible quality and has sufficient data rate and the necessary progressive structure to preserve the image quality of either format without compromises. .

Converting all inputs to a 3G 1080p format before they're combined in layers or through keys minimizes spatial artifacts because more pixels are utilized during the interpolation and filtering processes that do scaling, aspect ratio conversion and 2D/3D effects. The resulting pictures are clearer and sharper emanating from the highest production process available today.

Once converted to 1080p, signals are preserved in their highest format level. Providing outputs at other resolutions such as 1080i, 720p, 480i or even analog, and converting aspect ratios is essentially lossless. For example, converting 1080p to 1080i is a very straight-forward process that creates interlaced fields from progressive frames at the same rate. Similarly, converting 1080p to 720p involves a scaling process with negligible losses. The net result for producers is that footage and signals of any format can be mixed into the production without any degradation and 1080p masters can produce 720p, 1080i and SD copies that look just like these had been the original recording formats.

Superior Mixing with 1080p

1080p progressive processing is inherently less prone to motion artifacts than interlaced processing. Effects such as wipes, picture-in-picture boxes and 4:3/16:9 aspect correction are executed much more cleanly because all the pixels in a frame are processed at the same time. Interlaced processing has to deal with the fact that half the pixels in a frame are sampled at a different time and moving objects will be in a different position. This results in ragged edges on moving objects, apparent double-exposures and annoying shimmering effects on fine textures that are virtually impossible to filter out.

Only progressive processing can execute these effects without compromising the image.

Progressive-scan signals are also easier to compress than interlaced ones. In some instances 1080p originals actually produce better images at the same compression rate than either 720p or 1080i material, primarily because motion is easier to estimate. As a result, 1080p signals require very little extra compression bandwidth. Blu-Ray HD optical disks encode native 1080p signals as H.264 files and this is how the vast majority of them are released.

Exploiting the Emerging 3G 1080p Infrastructure

3G has been eagerly embraced by the production and manufacturing community. It's already the de-facto standard used in the latest generation of routers and terminal gear. Affordable 1080p LCD and plasma monitors, computers with 1080p outputs, and projectors with 1080p inputs have been introduced and 3G cameras are emerging into the HD market with increasing acceleration.

1080p displays are readily available to the public at very reasonable prices – ensuring that viewers can appreciate the full quality of the signal being sent to them. 'Full HD' flat-screen monitors are built with 1920x1080 pixel display panels - the 1:1 correspondence between pixels in the signal and the display eliminates any possibility of interpolation artifacts or lost pixels. They work best with progressive signals because the LCD and plasma technology they use is inherently progressive. Interlaced signals require an artifact-inducing de-interlacing processing stage.

1080p is also capable of displaying most computer signals natively. For the first time ever, producers can incorporate signals from computers up to 1920x1080 resolution without scan conversion and the degradation it introduces. Broadcast Pix Switchers can even accept DVI computer format signal connections and treat them like any other live source.

The long-awaited goal has finally been reached

With 3G there is no need to accept any more compromises in image quality: It offers the resolution of 1080i with the clarity and smooth motion rendition of 720p. It's the highest-quality production format available and is a optimum container for either of those formats. It finally offers video producers a production format approaching the quality of film.

For more information on Broadcast Pix 3G products, please visit us at www.broadcastpix.com.

Glossary

Progressive-scan	A television image scanning format where all lines and pixels in a frame are scanned sequentially in one pass, normally at a 1/60 or 1/50 second frame rate. The alternative is interlaced scanning.
Interlaced-scan	A television image scanning format where only half the lines are scanned at any time. This lowers the data rate of the picture while still outputting enough scans per second to reproduce motion acceptably. However, many artifacts are introduced when interlaced images are processed for effects, sampled as still frames, etc. The alternative is progressive scanning.
1080p	Progressive-scan 1920x1080 pixel images at a 1/60 or 1/50 second frame rate.
1080i	Interlaced-scan 1920x1080 pixel images. Two scans ('Fields') each with half the pixels in the image are sampled during a 1/30 or 1/25 second frame rate. Half the data rate of 1080p but has many artifacts introduced by interlacing process.
720p	Progressive-scan 1280x720 pixel images at a 1/60 or 1/50 second frame rate. Commonly used today for sports programming and other productions requiring good, artifact-free motion reproduction. But not as resolute as 1080-based images.
576i images.	25 Hz frame-rate "PAL-based" standard-definition digital signal. 720x576 pixel interlaced images.
486i images.	29.97 Hz frame-rate "NTSC-based" standard-definition digital signal. 720x486 pixel interlaced images.
Full HD	Marketing term used to indicate HD equipment (such as monitors) that can display native 1920x1080 images without any degradation. Monitors typically have displays that are 1920x1080 pixels, ensuring that there is a pixel-to-pixel correspondence between the signal and displayed image.
3 Gb/s	Data rate for a serial, single coax video and multiplexed data connection per SMPTE 424M. Calculated as: [total lines/frame]*[total pixels/line]*[# of quantizing bits]*[frame rate]*[Y,CrCb]. For 1080p/59.94, this calculation is [1125]*[2200]*[10]*[59.94]*[2] = 2.967 Gb/s. For 1080p/60 or 1080p/50 systems, this data rate is 2.97 Gb/s.
3G	Marketing term derived from 3 Gb/s but encompassing the 1080p standard.
Blu-Ray	Advanced DVD format supporting 1080p file format. Most Blu-Ray DVD's are encoded with 1080p-format video.

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