The Digital Fact Book
Converged media

20th anniversary edition

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A reference manual for the television broadcast & post production industries
includes stereoscopic 3D

Editor: Bob Pank

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Extract from a letter from Michael Faraday to J. Clerk Maxwell

Royal Institution, 13 November 1857

There is one thing I would be glad to ask you. When a mathematician engaged in investigating physical actions and results has arrived at his own conclusions, may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulae? If so, would it not be a great boon to such as we to express them so – translating them out of their hieroglyphics that we also might work upon them by experiment? I think it must be so, because I have found that you could convey to me a perfectly clear idea of your conclusions, which, though they may give me no full understanding of the steps of your process, gave me the results neither above nor below the truth, and so clear in character that I can think and work from them.

If this is possible, would it not be a good thing if mathematicians, writing on these subjects, were to give us their results in this popular useful working state as well as in that which is their own and proper to them?

Extract from "On Giants' Shoulders" by Melvyn Bragg

Hodder & Stoughton 1998

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This document is viewable as a standard PDF. However, it has been optimized for viewing in Adobe Acrobat 6.0 or later. Bookmarks have been included for added functionality, and can be found by clicking View > Navigation Panels/Tabs > Bookmarks. 'See also' references that have been included beneath entries can be clicked to view the associated information.

Quantel and digital technology

In 1973, the company now known as Quantel developed the first practical analog to digital converter for television applications. That innovation not only gave Quantel its name (QUANtized TELevision), it also started a process that has fundamentally changed the look of television, the way it is produced and delivered. Quantel's contribution to the changes leading to the digital age is best traced through its products, which have extended to film and print as well as television.

1975 Quantel demonstrates the **DFS 3000**, the world's first digital framestore synchronizer. TV coverage of the 1976 Montreal Olympic games is transformed with synchronized shots from an airship 'blimp' freely used and quarter-sized picture inserts mark the genesis of digital effects.

1977 The first portable digital standards converter, the **DSC 4002** heralds high quality and easily available conversion.

1978 **DPE 5000** series, the first commercially successful digital effects machine, popularizes digital video effects.

1980 The **DLS 6000** series introduces digital still storage for on-air presentation. The new **DFS 1751** framestore synchronizer is just one rack unit in height.

1981 The revolutionary **Paintbox**® creates the market for video graphics – and, thanks to continuous development, continues as the industry standard.

1982 **Mirage** introduces the TV page turn and is the first digital effects machine able to manipulate 3D images in 3D space.

1986 **Harry**® makes multi-layering of live video a practical proposition and introduces nonlinear operation and random access to video clips.

1988 Quantel publishes the first edition of the **Digital Fact Book**.

1989 **V-Series**, the second generation Paintbox, is faster, smaller and more powerful than its 'classic' predecessor.

1990 The **Picturebox**® stills store integrates the storage, presentation and management of stills. **Harriet**®, the dynamic graphics workstation manipulates still graphics over live video.

1992 **Henry**®, the Effects Editor, offers simultaneous layering of multiple live video sources. **Hal**®, the Video Design Suite, is the first custom-built, dedicated graphics production and compositing centre.

1993 **Dylan**® disk array technology provides fault-tolerant extended storage for non-compressed video with true random access to material. First applications are with **Hal**®, **Henry**® and the new **Editbox**® which introduces online nonlinear editing.

Domino®, digital opticals for movies, brings the flexibility of digital compositing and effects technology to the film industry. Its accuracy and speed open new horizons for movie making.

1994 The **Clipbox**® video server offers large-scale shared video storage for many users, each with true random access for input, editing and playout for news, sport, transmission and post-production.

1998 **Inspiration**™ the integrated news and sports production system offers the sought-after, fast-track end-to-end solution from lines-in to on-air. Stories edited at journalists' desktops are immediately ready for transmission.

1999 **Moving Picturebox**® extends Picturebox stills facilities to both video clips and stills.

2000 **iQ** is an entirely new platform for media editing and compositing. It serves as the centerpiece of modern post and is the mainstay of many Digital Intermediate facilities. It introduces Resolution Co-existence – working with all TV formats together, SD and HD, as well as with digital film. Its unique ultra-fast hardware and software architecture allows scalability and access for third-party developers.

2002 **generationQ** – a complete new line of products that offers total scalability in hardware and software. The post range includes the **iQ** media platform, the **eQ** mainstream HD/SD editor and **QEffects** software for PCs. Graphics includes the **gQ** high powered, multi-resolution platform, a new **Paintbox** for powerful SD graphics production and **QPaintbox** software for PCs. For broadcast, the totally scalable **sQ Server** combines broadcast and browse video within the same server, while the sQ View-Cut-Edit-Edit Plus range of applications encompasses everything from craft editing to journalist 'Cut and View', all running on a progressive, common interface.

2003 **QColor** – powerful in-context color correction option for iQ and eQ is introduced, integrating color correction into the heart of the mainstream post production process.

2005 **Newsbox** – a complete news system in a box, combining ingest, editing, playout and control within a single system that can be up and running within hours of unpacking. Quantel also introduced a novel approach to HD post production with its ‘Pay as you Go HD’ option for eQ – designed to give post houses and broadcasters a ‘soft start’ in HD production.

Pablo – complete color correction combining image-processing hardware with color correction software for quality, performance and interactivity for in-context color grading.

2006 **Pablo HD** – provides cost-effective Pablo power for HD and SD.

Marco – standalone desktop editing software with the Quantel editing interface that runs on a standard PC.

Newsbox – complete self-contained news system available in ‘HD now’ and ‘HD upgradeable’ configurations.

Revolver – secondary color correction in Pablo without using keys. Colorists can work intuitively on multiple levels within a picture to produce natural looking results.

2007 **Genetic Engineering** – a teamworking infrastructure for post and DI enabling different suites to work on the same clips at the same time with no compromises.

Stereoscopic 3D – tools for efficient handling of 3D shot material in post.

For the latest developments please contact Quantel or visit our website www.quantel.com

Introduction to the 20th anniversary edition

The team researching and writing the first edition of the Digital Fact Book back in 1987, when digital technology represented but occasional islands in the analog sea in which we all swam, could not possibly have imagined what our industry would look like today. Back then, digital was going to make the world so simple – fixing all our problems and making our lives easy.

But no one could have expected the explosion of choice that digital would bring, nor the unbelievable opportunities that have been brought about by new media channels, the internet and the mighty computer. This kind of explosion – perpetually driven yet further forward at breakneck speed by an endless stream of digital innovation – is exactly why we still need a Digital Fact Book. Today it's all about digital content for the whole universe – a world where the knowledge and skills of the traditional 'broadcasting' community has cemented a fruitful union with the new wave of 'all media' IT-based professionals. The result is a truly converged digital world – which is why this edition has 'converged media' as its subheading.

So what will the next 20 years bring? The team that put this edition together has absolutely no idea – but my goodness we know it's going to be good and we're looking forward to it! What is certain is that we will continue to track its unfolding with further editions of the Digital Fact Book.

We hope you find the new edition a useful source of reference in this exciting converged world. As ever, we welcome any comments or additions – email us at dfb@quantel.com.

Bob Pank

Abbreviations

bit	b	kilobit	kb
bits per second	b/s	kilobits per second	kb/s
byte	B	kilobyte	kB
bytes per second	B/s	kilohertz	kHz
frames per second	f/s	megabit	Mb
gigabits	Gb	megabyte	MB
gigabits per second	Gb/s	megahertz	MHz
gigabyte	GB	micro	µ
gigabytes per second	GB/s	seconds	s
gigahertz	GHz	terabit	Tb
hertz	Hz	terabyte	TB
hours	h		

TV standards descriptions

TV standards are written in many different ways. The method used in this book is shown below and follows how they appear in ITU-R BT 709: i.e. –

Number of pixels per line x number of lines per frame/vertical refresh rate (in Hz) progressive or interlaced (P or I). For example:

1920 x 1080/50I

Notes:

1) The vertical refresh rate shown for interlaced scans is twice the whole frame rate (two interlaced fields make up one whole frame). This assumes that interlace is only ever 2:1 (theoretically it can be greater but never is for broadcast purposes). So 1920 x 1080 50I has 25 whole frames per second.

2) Digital standards are usually quoted for the active lines and pixels only – so no blanking space is included

Examples:
Digital SDTV in Europe
720 x 576/50I
(analog equivalent is 625/50I that includes 49 lines of blanking)

An HD standard in USA
1920 x 1080/30P

Brief format
Lines per frame/vertical refresh rate, progressive or interlaced e.g.: 1080/30P

Digital terms

0:2:2

See: Dual Link

1000/1001

The nominal 30 frames/60 fields per second of NTSC color television is usually multiplied by 1000/1001 (= 0.999) to produce slightly reduced rates of 29.97 and 59.94 Hz. This offset gives rise to niceties such as drop-frame timecode (dropping one frame per thousand – 33.3 seconds) and audio that also has to run at the right rate. Although having strictly analog origins from the very beginning of NTSC transmissions as a fix-it to avoid a clash of frequencies, it has also been extended into the digital and HD world where 24 Hz becomes 23.97 and 30 frames/60 fields per second are again changed to 29.97 and 59.94 Hz. Of course, as the frame/field frequency changes, so do the line and color subcarrier frequency as all are locked together. Note that this does not apply to PAL color systems as these always use the nominal values (25 Hz frame rate).

The reason for the 1000/1001 offset is based in monochrome legacy. Back in 1953, the NTSC color subcarrier was specified to be half an odd multiple (455) of line frequency to minimize the visibility of the subcarrier on the picture. Then, to minimize the beats between this and the sound carrier, the latter was to be half an even multiple of line frequency, and to ensure compatibility with the millions of existing monochrome TV sets, the sound carrier was kept unchanged – at 4.5 MHz – close to 286 times the line frequency (Fl). Then, in a real tail-wags-dog episode, it was decided to make this exactly 286 times... by slightly altering the line frequency of the color system (and hence that of the color subcarrier and frame rate). Interestingly it is said that the problem could soon have been solved with a little improved engineering, so avoiding the need for this awkward frequency offset and all the many thousands of hours of additional engineering and operational effort this has caused down the years.

Here's the math.

Fl = frames per second x number of lines per frame

Nominally this is	30 x 525	= 15,750 kHz
But it was decided that:		
	286 x Fl	= 4.5 MHz
So	Fl = 4,500,000/286	= 15,734.265 kHz
This reduced Fl by	15734.265/15750	= 1000/1001 or 0.999

As all frequencies in the color system have to be in proportion to each other, this has made:

NTSC subcarrier (Fl x 455/2)	= 3.579 MHz
30 Hz frame rate (Fl/number of lines per frame)	= 29.97 Hz

Following on, all digital sampling locked to video is affected so, for example, nominal 48 and 44.1 kHz embedded audio sampling becomes 47.952 and 44.056 kHz respectively.

As reasons for 'drop-frame' are analog it is not an inherent requirement of digital television. So with maybe with the US analog switch off on 17 February 2009 we can start ditching drop-frame?

See also: Drop-frame timecode, Embedded audio

10-bit lin

A type of digital sampling of analog images that creates 10-bit (2^{10}, 1024 possible levels) numbers to describe the post gamma corrected analog brightness levels of an image. Lin, short for 'linear' means the levels are assigned equally to the levels of the post gamma corrected analog signal they describe. So an LSB change describes the same change in level if it is in a bright area or a dark area of the picture. Most professional HD and some SD television is sampled this way according to ITU-R BT.601 and 709. 10-bit lin sampling allows good quality to be maintained through TV production and post production where the processes can make particular demands outside the range of normal viewing, and so produce good results for viewers. However if color grading is required then the useful wide dynamic range that can be described by 10-bit log would be preferable.

See also: 10-bit log, gamma

10-bit log

This usually refers to a 10-bit sampling system that maps analog values logarithmically rather than linearly. It is widely used when scanning film images which are themselves a logarithmic representation of the film's exposure. This form of sampling is now available directly from some digital cinematography cameras.

The 10-bit data can describe 2^{10} or 1024 discrete numbers, or levels: 0-1023 for each of the red, blue and green (RGB) planes of an image. However, as all electronic light sensors have a linear response and so produce an output directly proportional to the light they see, when scanning film they represent the transmittance of the film. Usually it is negative film that is scanned and this means a large portion of the numbers generated describe the scene's black and dark areas (representing bright areas of the original scene), and too few are left for the light areas (dark scene) where 'banding' could be a problem – especially after digital processing such as grading and color correction. Transforming the numbers into log (by use of a LUT) gives a better distribution of the digital detail between dark and light areas and, being better matched to the eyes' response, offers good rendition over the whole brightness range without having to use more bits. A minimum of 13-bits linear sampling converted to 10-bit log sampling means sufficient detail in the pictures is stored to allow headroom for downstream grading that is common in film production.

10-bit log is the basis for sampling in the Cineon and SMPTE DPX formats that are widely used in the post production and DI industries.

See also: 10-bit lin

13.5 MHz

This is the sampling frequency of luminance in SD digital television. It is represented by the 4 in 4:2:2. The use of the number 4 is pure nostalgia as 13.5 MHz is in the region of 14.3 MHz, the sampling rate of 4 x NTSC color subcarrier (3.58 MHz), used at the very genesis of digital television equipment.

Reasons for the choice of 13.5 MHz belong to politics, physics and legacy. Politically it had to be global and work for both 525/60 (NTSC) and 625/50 (PAL) systems. The physics is the easy part; it had to be significantly above the Nyquist frequency so that the highest luminance frequency, 5.5 MHz for 625-line PAL systems, could be faithfully reproduced from the sampled digits – i.e. sampling in excess of 11 MHz - but not so high as to produce unnecessary, wasteful amounts of data. Some math is required to understand the legacy.

The sampling frequency had to produce a static pattern on both 525 and 625-line standards, otherwise it would be very complicated to handle and, possibly, restrictive in use. In other words, the frequency must be a whole multiple of the lines speeds of both standards.

The line frequency of the 625/50 system is simply 625 x 25 = 15,625 Hz

(NB 50 fields/s makes 25 frames/s)

So line length is 1/15,625 = 0.000064 or 64μs

The line frequency of the 525/60 NTSC system is complicated by the need to offset it by a factor of 1000/1001 to avoid interference when transmitted. The line frequency is 525 x 30 x 1000/1001 = 15,734.265 Hz. This makes line length 1/15,734.265 = 63.5555μs

The difference between the two line lengths is 64 – 63.55555 = 0.4444μs

This time divides into 64μs exactly 144 times, and into 63.5555μs exactly 143 times. This means the lowest common frequency that would create a static pattern on both standards is 1/0.4444 MHz, or 2.25 MHz.

Now, back to the physics. The sampling frequency has to be well above 11 MHz, so 11.25 MHz (5 x 2.25) is not enough. 6 x 2.25 gives the sampling frequency that has been adopted – 13.5 MHz.

Similar arguments have been applied to the derivation of sampling for HD. Here 74.25 MHz (33 x 2.25) is used.

*See: 4:1:1, 4:2:0, 4:2:2, 4:4:4, 4*f_{sc}*, Nyquist (frequency)*

14:9

A picture aspect ratio that has been used as a preferred way to present 16:9 images on 4:3 screens. It avoids showing larger areas of black above and below letterboxed pictures but does include more of the 16:9 image than 4:3. It is commonly used for analog transmissions that are derived from 16:9 digital services.

16:9

Picture aspect ratio used for HDTV and some SDTV (usually digital).

See also: 14:9, 4:3, Widescreen

24P

Refers to 24 frames-per-second, progressive scan. 24 f/s has been the frame rate of motion picture film since talkies arrived. It is also one of the rates allowed for transmission in the DVB and ATSC digital television standards – so they can handle film without needing any frame-rate change (3:2 pull-down for 60 fields/s 'NTSC' systems or running film fast, at 25f/s, for 50 Hz 'PAL' systems). 24P is now accepted as a part of television production formats – usually associated with high definition 1080 lines to give a 'filmic' look on 60 Hz TV systems.

A major attraction is a relatively easy path from this to all major television formats as well as offering direct electronic support for motion picture film and D-cinema. However, the relatively slow refresh rate has drawbacks. For display it needs to be double shuttered – showing each frame twice to avoid excessive flicker, as in cinema film projection, and fast pans and movements are not well portrayed. Faster vertical refresh rates are preferred for sports and live action.

See also: 24PsF, 25P, 3:2 Pull-down, ATSC, Common Image Format, DVB, Versioning

24PsF (segmented frame)

A system for recording 24P images in which each image is segmented – recorded as odd lines followed by even lines. Unlike normal television, the odd and even lines are from an image that represents the same snapshot in time. It is analogous to the scanning of film for television. This way the signal is more compatible (than normal progressive) for use with video systems, e.g. VTRs, SDTI or HD-SDI connections, mixers/switchers etc., which may also handle interlaced scans. Also it can easily be viewed without the need to process the pictures to reduce 24-frame flicker.

See also: Interlace Factor, Progressive

25P

Refers to 25 f/s, progressive scan. Despite the international appeal of 24P, 25P is widely used for HD productions in Europe and other countries using 50 Hz TV systems. This is a direct follow-on from the practice of shooting film for television at 25 f/s.

See also: 24P, 24PsF, Common Image Format, DVB

2K

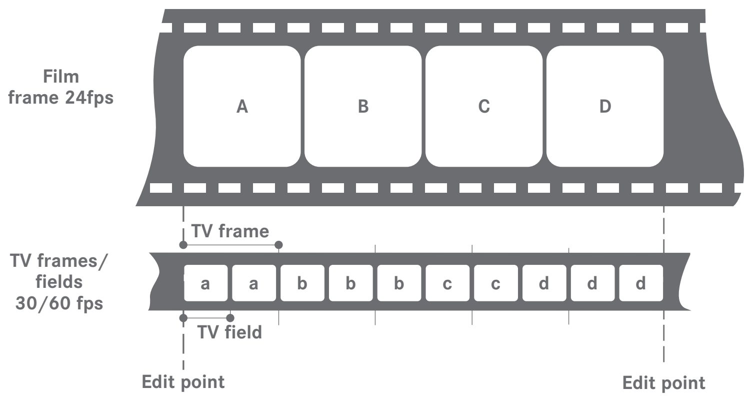
See Film formats

3:2 Pull-down (a.k.a. 2:3 Pull-down)

A method used to map the 24 or 23.98 f/s of motion picture film onto 30 or 29.97 f/s (60 or 59/94 fields) television, so that one film frame occupies three TV fields, the next two, etc., It means the two fields of every other TV frame come from different film frames making operations such as rotoscoping impossible, and requiring care in editing. Quantel equipment can unravel the 3:2 sequence to allow clean frame-by-frame treatment and subsequently re-compose 3:2.

The 3:2 sequence repeats every $1/6^{th}$ of a second, i.e. every five TV frames or four film frames, the latter identified as A-D. Only film frame A is fully on a TV frame and so exists at one timecode only, making it the only editable point of the video sequence.

Film-to-TV transfer



3:2 pull-down creates a field-based result in that every other frame contains frames comprising two different fields. This makes subsequent compression, which then has to be based on 60 fields/s, less efficient than working with 30 frames/s. This may affect delivery platforms from TV broadcast to DVDs.

3D (graphics)

Applied to graphics, this describes graphics objects that are created and shown as three-dimensional objects. As computer power has increased, so has the ability to cost-effectively produce more and more detailed 3D graphic results – as seen in feature length animations. For television presentation, live 3D computer graphics is now commonplace – even in HD. The considerable computational power needed for this is generally supplied by GPUs.

3D (stereo)

In television, film or cinema, 3D may refer to material that is shot using a set of 'stereo' cameras and shown on the screen as a pair of superimposed stereo images (usually 'decoded' by the viewer with polarized spectacles). Also known as stereo3D and stereoscopic 3D.

See also: Stereoscopy

3G SDI

See: Serial Digital Interface

4:1:1

This is a set of sampling frequencies in the ratio 4:1:1, used to digitize the luminance and color difference components (Y, R-Y, B-Y) of a video signal. The 4 represents 13.5 MHz, (74.25 MHz at HD) the sampling frequency of Y, and the 1s each 3.75 MHz (18.5625) for R-Y and B-Y (ie R-Y and B-Y are each sampled once for every four samples of Y).

With the color information sampled at half the rate of the 4:2:2 system, this is used as a more economic form of sampling where video data rates need to be reduced. Both luminance and color difference are still sampled on every line but the latter has half the horizontal resolution of 4:2:2 while the vertical resolution of the color information is maintained. 4:1:1 sampling is used in DVCPRO (625 and 525 formats), DVCAM (525/NTSC) and others.

Raster line

Pixels	•	•	•	•	•	•	•	•	•
	Y	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	C_r				C_r				C_r
	C_b				C_b				C_b

See also: 4:2:0, 4:2:2, DV (DVCAM and DVCPRO)

4:2:0

A sampling system used to digitize the luminance and color difference components (Y, R-Y, B-Y) of a video signal. The 4 represents the 13.5 MHz (74.25 MHz at HD) sampling frequency of Y while the R-Y and B-Y are sampled at 6.75 MHz (37.125 MHz) – effectively on every other line only (ie one line is sampled at 4:0:0, luminance only, and the next at 4:2:2).

This is used in some 625-line systems where video data rate needs to be reduced. It decreases the overall data by 25 percent against 4:2:2 sampling and the color information has a reasonably even resolution in both the vertical and horizontal directions. 4:2:0 is widely used in MPEG-2 coding meaning that the broadcast and DVD digital video seen at home is usually sampled this way. 625 DV and DVCAM coding also use 4:2:0. However the different H and V chroma bandwiths make it inappropriate for post applications.

See also: 4:1:1, 4:2:2, DV (DVCAM), MPEG-2

4:2:2

A ratio of sampling frequencies used to digitize the luminance and color difference components (Y, R-Y, B-Y) of an image signal. The term 4:2:2 denotes that for every four samples of the Y luminance, there are two samples each of R-Y and B-Y, giving less chrominance (color) bandwidth in relation to luminance. This compares with 4:4:4 sampling where full same bandwidth is given to all three channels – in this case usually sampled as RGB.

The term 4:2:2 originated from the ITU-R BT.601 digital video sampling where 4:2:2 sampling is the standard for digital studio equipment. The terms '4:2:2' and '601' are commonly (but technically incorrectly) used synonymously in TV. For SD the sampling frequency of Y is 13.5 MHz and that of R-Y and B-Y is each 6.75 MHz, providing a maximum color bandwidth of 3.37 MHz – enough for high quality chroma keying. For HD the sampling rates are 5.5 times greater, 74.25 MHz for Y, and 37.125 MHz for R-Y and B-Y.

The origin of the term is steeped in digital history and should strictly only be used to describe a specific format of standard definition digital television sampling. However, it is widely used to describe the sampling frequency ratios of image components (Y, B-Y, R-Y) of HD, film and other image formats.

See also: 13.5 MHz, Co-sited sampling, Digital keying, ITU-R BT.601, ITU-R BT.709, Nyquist

4:2:2:4

This is the same as 4:2:2 but with the key signal (alpha channel) included as the fourth component, also sampled at 13.5 MHz (74.25 MHz at HD).

See also: Dual link

4:3

The aspect ratio of PAL and NTSC traditional television pictures, originally chosen to match 35mm film. All broadcast television pictures were 4:3 until the introduction of high definition when a wider image was considered to be more absorbing for viewers. For display tube manufacturers the most efficient aspect ratio would be 1:1 – square – as this is inherently the strongest, uses less glass and weighs less. 16:9 tubes are more expensive to produce. Such restraints do not apply to panels basic on LED, Plasma or SED technologies.

4:4:4

One of the ratios of sampling frequencies used to digitize the luminance and color difference components (Y, B-Y, R-Y) or, more usually, the RGB components of a video signal. In this ratio there is always an equal number of samples of all components. RGB 4:4:4 is commonly used in standard computer platform-based equipment, when scanning film or for high-end post including that used for cinematography.

In the converged media world, big screen requirements for cinema demand a new high level of picture quality. Film is commonly scanned in RGB for digital intermediate and effects work, and recorded directly to disks. The signal is then kept in the RGB form all the way through the DI process to the film recorder – making the best use of the full RGB data. For the rapidly growing market of digital cinema exhibition the DCI has recommended X´Y´Z´ chromaticity which can be derived from RGB using a 3D LUT.

See also: 2K, X´ Y´ Z´, Digital intermediate, Dual link

4:4:4:4

As 4:4:4, except that the key signal (a.k.a. alpha channel) is included as a fourth component, also sampled at 13.5 MHz (74.25 MHz at HD).

See also: Dual link

422P@ML

See MPEG-2

4f_{sc}

A sampling rate locked to four times the frequency of color subcarrier (f_{sc}). For example, D2 and D3 digital VTRs, little used today, sample composite video at the rate of 4 x color subcarrier frequency (i.e. 17.7 MHz PAL and 14.3 MHz NTSC). Its use is declining as all new digital equipment is based on component video where color subcarrier does not exist and sampling clock signals are derived from the line frequency.

See also: Component video

A

4K

See Film formats

5.1 Audio

See Discrete 5.1 Audio

50P and 60P

These indicate a video format that has 50 or 60 progressive frames per second and usually refers to high definition. The original digital television standards only included progressive frame rates above 30 Hz for image sizes up to 720 lines – thus limiting the total video data. More recently this has been expanded up to 60 Hz for the larger 1080-line television standards to provide the best of the best – the maximum HD image size with a fast rate for rendition of fast action and progressive frames for optimum vertical resolution (better than interlaced scans). The baseband signal produces twice the data rates of the equivalent interlaced (50I and 60I) formats, pushing up equipment specifications.

See also: SDI (3G SDI)

601

See ITU-R BT.601

709

See ITU-R BT.709

7.1

See Discrete 5.1 Audio

8 VSB/16 VSB

See VSB

AAC

Advanced Audio Coding, a codec originally known as MPEG-2 NBC (non-backwards compatible), is considered the successor to MP3, with about 25 percent efficiency improvement. However this performance has more recently been considerably enhanced with **aacPlus**, also known as High Efficiency AAC (HE-AAC), and included in MPEG-4 and delivers CD quality stereo at 48 kb/s and 5.1 surround sound at 128 kb/s.

Websites: (AAC) www.audiocoding.com, (aacPlus) www.codingtechnologies.com

AAF

The Advanced Authoring Format – an industry initiative, launched in 1998, to create a file interchange standard for the easy sharing of media data and metadata among digital production tools and content creation applications, regardless of platform. It includes EBU/SMPTE metadata and management of pluggable effects and codecs. It allows open connections between equipment where video, audio and metadata, including information on how the content is composed, where it came from, etc., are transferred. It can fulfill the role of an all-embracing EDL or offer the basis for a media archive that any AAF-enabled system can use. Quantel products make extensive use of AAF.

In 2007 AAF Association, Inc. changed its name to Advanced Media Workflow Association (AMWA), with the tag 'Putting AAF and MXF to work', with direction and focus on file-based workflows including AAF, MXF and other formats. It is involved with the MXF Mastering Format Project that aims to provide real-world solutions for key workflows, focusing on creating a single MXF master file from which multiple versions of a program may be created.

Website: www.aafassociation.org

AC-3

See Dolby Digital

Accommodation (Stereoscopic)

The ability of our eyes to refocus at a new point of interest.

In normal vision, the processes of focusing on objects at different distances (accommodation) and convergence/divergence (the angle between the lines of sight of our eyes) are linked by muscle reflex. A change in one creates a complementary change in the other. However, watching a stereoscopic film or TV program requires the viewer to break the link between these different processes by accommodating at a fixed distance (the screen) while dynamically varying eye convergence and divergence (something we don't do in life and can quickly lead to headaches if over-used in stereo3D) to view objects at different stereoscopic distances.

Active line

The part of a television line that actually includes picture information. This is usually over 80 percent of the total line time. The remainder of the time was reserved for scans to reset to the start of the next line in camera tubes and CRT screens. Although the imaging and display technologies have moved on to chips and panels, there remains a break (blanking) in the sampling of digital TV as in ITU-R BT.601 and ITU-R BT 709. These 'spaces' carry data for the start of lines and pictures, as well as other information such as embedded audio tracks.

See also: Active picture

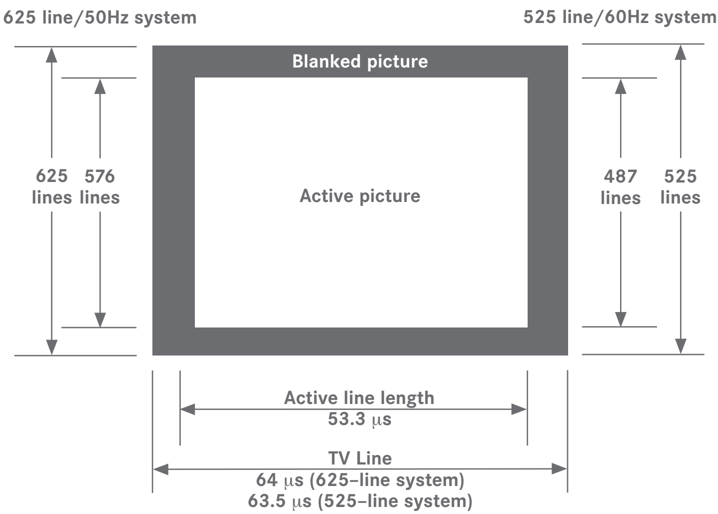
Active picture

The area of a TV frame that carries picture information. Outside the active area there are line and field blanking which roughly, but not exactly, correspond to the areas defined for the original 525- and 625-line analog systems. In digital versions of these, the blanked/active areas are defined by ITU-R BT.601, SMPTE RP125 and EBU-E.

For 1125-line HDTV (1080 active lines), which may have 60, 30, 25 or 24 Hz frame rates (and more), the active lines are always the same length – 1920 pixel samples at 74.25 MHz – a time of 25.86 microseconds – defined in SMPTE 274M and ITU-R.BT 709-4. Only their line blanking differs so the active portion may be mapped pixel-for-pixel between these formats. DTV standards tend to be quoted by only their active picture content, eg 1920 x 1080, 1280 x 720, 720 x 576, as opposed to analog where the whole active and blanked areas are included, such as 525 and 625 lines.

For both 625 and 525 line formats active line length is 720 luminance samples at 13.5 MHz = 53.3 microseconds. In digital video there are no half lines as there are in analog. The table below shows blanking for SD and some popular HD standards.

Analog Format	625/50	525/60	1125/60I	1125/50I	1125/24P
Active lines Blanking	576	487	1080	1080	1080
Field 1 lines	24	19	22	22	45/frame
Field 2 lines	25	19	23	23	–
Line blanking	12µs	10.5µs	3.8µs	9.7µs	11.5µs



ADC or A/D

Analog to Digital Conversion. Also referred to as digitization or quantization. The conversion of analog signals into digital data – normally for subsequent use in digital equipment. For TV, samples of audio and video are taken, the accuracy of the process depending on both the sampling frequency and the resolution of the analog amplitude information – how many bits are used to describe the analog levels. For TV pictures 8 or 10 bits are normally used; for sound, 16, 20 or 24 bits are common. The ITU-R BT.601 standard defines the sampling of video components based on 13.5 MHz, and AES/EBU defines sampling of 44.1 (used for CDs) and 48 kHz for audio. For pictures the samples are called pixels, which contain data for brightness and color.

See also: AES/EBU, Binary, Bit, Into digits (Tutorial 1), Pixel

ADSL

Asymmetrical Digital Subscriber Line – working on the copper 'local loop' normally used to connect phones, ADSL provides a broadband downstream channel (to the user) of maximum 8 Mb/s and a narrower band upstream channel (from the user) of maximum 128-1024 kb/s, according to class. Exactly how fast it can run ultimately depends on the performance of the line, often dictated by the distance from the telephone exchange where the DSLAM terminates the line. The highest speeds are usually only available within 1.5 km of the DSLAM. The service is normally always-on, no need to dial up. Its uses include high-speed Internet connections and streaming video.

A newer version, ADSL-2 can run up to 12 Mb/s up to 2.5 km, and ADSL-2+ can deliver 24 Mb/s over up to 1.5 km. ADSL-2/2+ effectively doubles this rate by putting two services together. (All distances are approximate). These are sufficient to carry live SD or HD provided that the service is continuous, or can be recorded before viewing.

See also: Broadband, DSL

AES/EBU

The Audio Engineering Society (AES) and the EBU (European Broadcasting Union) together have defined a standard for Digital Audio, now adopted by ANSI (American National Standards Institute). Commonly referred to as 'AES/EBU' and officially as AES3, this digital audio standard permits a variety of sampling frequencies, for example CDs at 44.1 kHz, or DATs and digital VTRs at 48 kHz. 48 kHz is widely used in broadcast TV production although 32-192 kHz are allowed. One cable and connector, usually an XLR, carries two channels of digital audio.

See also: Word clock
For further reading – see Appendix
Website: www.aes.org

A

Aliasing
Undesirable 'beating' effects caused by sampling frequencies being too low faithfully to reproduce image detail. Examples are:

1) Temporal aliasing – e.g. wagon wheel spokes apparently reversing, also movement judder seen in the output of standards converters with insufficient temporal filtering.

2) Raster scan aliasing – twinkling effects on sharp boundaries such as horizontal lines. Due to insufficient filtering this vertical aliasing and its horizontal equivalent are often seen in lower quality DVEs as detailed images are compressed.

The 'steppiness' or 'jaggies' of poorly filtered lines presented at an angle to the TV raster is also referred to as aliasing.

See also: Anti-aliasing, Interpolation (temporal & spatial), Into digits (Tutorial 1)

Aliens
A familiar term for alias effects, such as ringing, contouring and jaggy edges caused by lack of resolution in a raster image. Some can be avoided by careful filtering or dynamic rounding.

Alpha channel
Another name for key channel – a channel to carry a key signal.

See also: Keying, 4:4:4:4

Anaglyph (Stereoscopic)
A type of stereoscopy in which the left eye and right eye images are separated by color filtering and then superimposed as a single image rather than two separate images. Each eye sees only the required image through the use of complementary colored filters (e.g. red and green or red and cyan). Anaglyph glasses have been popular over the years for viewing 3D comics and some 3D films (particularly on VHS and DVD).

See also: 3D

Anamorphic
Generally refers to the use of 16:9 aspect ratio pictures in a 4:3 system. For example, anamorphic supplementary lenses are used to change the proportions of an image to 16:9 on the surface of a 4:3 sensor by either extending the horizontal axis or compressing the vertical. Signals from 16:9 cameras and telecines produce an 'anamorphic' signal which is electrically the same as with 4:3 images but will appear horizontally squashed if displayed at 4:3.

The alternative way of carrying 16:9 pictures within 4:3 systems is letterbox. Letterbox has the advantage of showing the correct 16:9 aspect ratio on 4:3 displays, however the vertical resolution is less than 16:9 anamorphic.

See also: Aspect ratio – of pictures

Answer print

The answer print, also called the first trial print, is the first print made from edited film and sound track. It includes fades, dissolves and other effects. It is used as the last check before running off the release prints from the internegatives.

Anti-aliasing

Smoothing of aliasing effects by filtering and other techniques. Most, but not all, DVEs and character generators contain anti-aliasing facilities.

See also: Aliasing, Interpolation (spatial), Interpolation (temporal)

API

Application Programming Interface – a set of interface definitions (functions, subroutines, data structures or class descriptions) which provide a convenient interface to the functions of a subsystem. They also simplify interfacing work by insulating application programmers from minutiae of the implementation.

Arbitrated Loop (AL)

A technique used on computer networks to ensure that the network is clear before a fresh message is sent. When it is not carrying data frames, the loop carries 'keep-alive' frames. Any node that wants to transmit places its own ID into a 'keep-alive' frame. When it receives that frame back it knows that the loop is clear and that it can send its message.

See also: Fiber Channel

ARC

Aspect Ratio Converters change picture aspect ratio – usually between 16:9 and 4:3. Other aspect ratios are also allowed for, such as 14:9. Custom values can also be used. Technically, the operation involves independent horizontal and vertical resizing and there are a number of choices for the display of 4:3 originals on 16:9 screens and vice versa (e.g. letterbox, pillar box, full height and full width). Whilst changing the aspect ratio of pictures, the objects within should retain their original shape with the horizontal and vertical axes expanded equally.

See also: Aspect ratio

A

Archive

Long-term storage of information. Pictures, sound and metadata stored in digital form can be archived and recovered without loss or distortion. The storage medium must be both reliable and stable and, as large quantities of information need to be stored, cost is of major importance. Currently the lowest cost is magnetic tape but there is increasing interest in optical disks and especially DVDs which offer far better access.

VTRs offer the most cost-effective storage for video with the highest packing density and instant viewing – even while spooling. Non-compressed component digital formats: HDCAM SR, D1, D5 (SD) and D6 (HD) give the best quality and 50 Mb/s 3:1 compression for SD is also used (DVCPRO 50, IMX). However, VTRs are format dependent so their long-term use is limited for the world which is increasingly format co-existent.

For archiving stills and graphics any compression should be avoided as full detail is required for viewing their detail. CDs and DVDs are convenient, giving instant access to all pictures.

Today, networking, the proliferation of video formats and the use of digital film have meant a move away from VTRs toward data recorders. LTO-2 and 3 are is increasingly used for archiving.

Traditionally, material is archived after its initial use – at the end of the process. More recently some archiving has moved to the beginning. An example is news where, in some cases, new material is archived and subsequent editing, etc., accesses this. This reflects the high value of video assets where rapidly increasing numbers of television channels are seeking material.

See also: AAF, Data recorders, DTF, Optical disks

Areal density

The density of data held on an area of the surface of a recording medium. This is one of the parameters that manufacturers of disk drives and tape recorders strive to increase. For example some currently available high-capacity drives achieve over 15 Gb/square inch. Looking forward, Seagate have reported achieving over 421Gb/square inch in a lab demonstration. This is over a four-fold increase in six years, so capacities and performance can still be expected to continue to grow for some time yet. Much of the latest gain has been made by perpendicular recording that stores data tracks down into the disk, as well as on the surface. Seagate predicts the common 3.5-inch format hard drive offering up to 2.5 TB in 2009.

See also: Hard disk drives
Website: www.seagate.com

ARPU

Average Revenue Per Unit – usually used by telecoms companies, to describe the money made from each 'unit' or 'customer'!

Artifact

Particular visible effects which are a direct result of some technical limitation. Artifacts are generally not described by traditional methods of signal evaluation. For instance, the visual perception of contouring in a picture cannot be described by a signal-to-noise ratio or linearity measurement.

ASCII

American Standard Code for Information Interchange. This is a standard computer character set used throughout the industry to represent keyboard characters as digital information. There is an ASCII table containing 127 characters covering all the upper and lower case characters and non displayed controls such as carriage return, line feed, etc. Variations and extensions of the basic code are used in special applications.

ASIC

Application Specific Integrated Circuit. Custom-designed integrated circuit with functions specifically tailored to an application. These replace the many discrete devices that could otherwise do the job but work up to ten times faster with reduced power consumption and increased reliability. ASICs are now only viable for very large-scale high volume products due to high startup costs and their inflexibility as other programmable devices, such as FPGAs (field programmable gate arrays), offer more flexible and cheaper opportunities for small to medium-sized production levels.

See also: PLD

Aspect ratio

1. – of pictures. The ratio of length to height of pictures. All TV screens used to be 4:3, i.e. four units across to three units in height, but now almost all new models, especially where there is digital television, are widescreen, 16:9. Pictures presented this way are believed to absorb more of our attention and have obvious advantages in certain productions, such as sport. In the change towards 16:9 some in-between ratios have been used for transmission, such as 14:9.

See also: Anamorphic, Widescreen, HDTV

2. – of pixels. The aspect ratio of the area of a picture described by one pixel. The ITU-R BT.601 digital coding standard defines luminance pixels which are not square. In the 525/60 format there are 486 active lines each with 720 samples of which 711 may be viewable due to blanking. Therefore the pixel aspect ratios on 4:3 and 16:9 screens are:

486/711 x 4/3 = 0.911 (tall
487/711 x 16/9 = 1.218 (wide)

For the 625/50 format there are 576 active lines each with 720 samples of which 702 are viewable so the pixel aspect ratios are:

576/702 x 4/3 = 1.094 (wide)
576/702 x 16/9 = 1.458 (wider)

The digital HD image standards all define square pixels.

Account must be taken of pixel aspect ratios when, for example, executing DVE moves such as rotating a circle. The circle must always remain circular and not become elliptical. Another area where pixel aspect ratio is important is in the movement of images between platforms, such as computers and television systems. Computers generally use square pixels so their aspect ratio must be adjusted for SD television-based applications.

See also: ARC, Pixel

Asynchronous (data transfer)

Carrying no separate timing information. There is no guarantee of time taken but a transfer uses only small resources as these are shared with many others. A transfer is 'stop-go' – depending on handshakes to check data is being received before sending more. Ethernet is asynchronous. Being indeterminate, asynchronous transfers of video files are used between storage devices, such as disks, but are not ideal for 'live' operations.

See: Ethernet, Isochronous, Synchronous

ATM
Asynchronous Transfer Mode (ATM) provides connections for reliable transfer of streaming data, such as television. With speeds ranging up to 10Gb/s it is mostly used by telcos. 155 and 622Mb/s are most appropriate for television operations. Unlike Ethernet and Fibre Channel, ATM is connection-based: offering good Quality of Service (QoS) by establishing a path through the system before data is sent.

Sophisticated lower ATM Adaptation Layers (AAL) offer connections for higher layers of the protocol to run on. AAL1 supports constant bit rate, time-dependent traffic such as voice and video. AAL3/4 supports variable bit rate, delay-tolerant data traffic requiring some sequencing and/or error detection. AAL5 supports variable bit rate, delay-tolerant connection-oriented data traffic – often used for general data transfers.

Website: www.atmforum.com

ATSC
The (US) Advanced Television Systems Committee. Established in 1982 to co-ordinate the development of voluntary national technical standards for the generation, distribution and reception of high definition television. In 1995 the ATSC published "The Digital Television Standard" which describes the US Advanced Television System. This uses MPEG-2 compression for the video and AC-3 for the audio and includes a wide range of video resolutions (as described in ATSC Table 3) and audio services (Table 2). It uses 8 and 16 VSB modulation respectively for terrestrial and cable transmission.

See also: VSB, Table 3, Dolby Digital (DD/AC-3), MPEG-2
Website: www.atsc.org

ATV
Advanced Television. The term used in North America to describe television with capabilities beyond those of analog NTSC. It is generally taken to include digital television (DTV) and high definition (HDTV).

Auditory masking
The psycho-acoustic phenomenon of human hearing where what can be heard is affected by the components of the sound. For example, a loud sound will mask a soft sound close to it in frequency. Audio compression systems such as Dolby Digital and MP3 audio use auditory masking as their basis and only code what can be heard by the human ear.

See also: Dolby Digital, MP3

AVC
See MPEG-4

A

AVCHD

Advanced Video Codec High Definition, a joint development between Panasonic and Sony, applies MPEG-4's AVC video coding and Dolby Digital (AC-3) or linear PCM audio coding, to meet the needs of the high definition consumer market with 1080i and 720p formats. The use of AVC provides at least twice the efficiency of MPEG-2 coding, used in HDV and MiniDV, to offer longer recording times or better pictures – or both. Possible recording media include standard DVD disks, flash memory and hard drives.

AVC-Intra

A codec that is H.264-compliant and uses only intra-frame compression. AVC-Intra technology, aimed at professional users, has been adopted by Panasonic for its P2 cameras (AVC-Intra P2) and offers considerably more efficient compression than the original DVCPRO HD codec – maybe as much as 2:1. It is significant that Panasonic have chosen to keep with intra-frame coding (GOP of 1) making the coded material easily editable at every frame. This is at a time when long GOP coding is being used in products including HDV and XDCAM HD. With increased coding efficiency some believe the use of long GOP coding in professional recorders will fade.

See also: DVCPRO P2, MPEG-4

AVI (.avi)

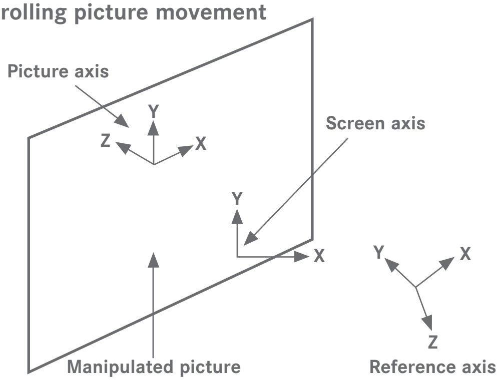
Audio Video Interleave – a Microsoft multimedia container format introduced in 1992 as part of its Video for Windows technology. AVI files can hold audio and video data in a standard container and provide synchronous video/audio replay. Most AVI files also use the OpenDML file format extensions, forming AVI 2.0 files.

Some consider AVI outdated, as there are significant overheads using it with popular MPEG-4 codecs that seemingly unduly increase file sizes. Despite that, it remains popular among file-sharing communities – probably due to its high compatibility with existing video editing and playback software, such as Windows Media Player.

A
B

Axis (x, y, z)
Used to describe the three-dimensional axes set at right angles to each other, available in DVE manipulations. At normal x lies across the screen left to right, y up the screen bottom to top and z points into the screen. Depending on the power of the equipment and the complexity of the DVE move, several hierarchical sets of xyz axes may be in use at one time. For example, one set may be referred to the screen, another to the picture, a third offset to some point in space (reference axis) and a fourth global axis controlling any number of objects together.

Axes controlling picture movement



See also: DVE, Keyframe

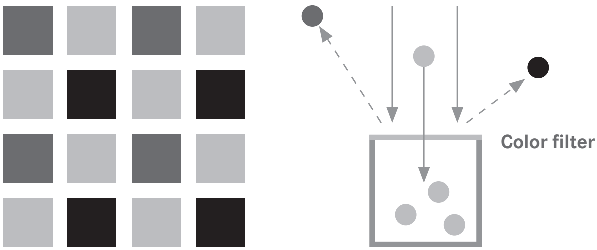
Background loading
Recording material into a system, such as a nonlinear editor, as a background task. Thus the foreground task continues uninterrupted and when one job is completed, the next is already loaded – potentially increasing the throughput of the editing system.

Background task
A secondary operation that is completed while the main (foreground) operation continues uninterrupted. This requires an overhead in machines' capabilities beyond that needed for their primary foreground operation. This has particular benefits in pressured situations where time is short, or simply not available for extra operations – such as during edit sessions, live programming and transmission. Examples are Quantel's use of Gigabit Ethernet for the background transfers of pictures, video, audio and metadata. The equipment is designed so it continues its primary foreground operations during all such transfers.

Bandwidth
The amount of information that can be passed in a given time. In television a large bandwidth is needed to show sharp picture detail in realtime, and so is a factor in the quality of recorded and transmitted images. For example, ITU-R BT.601 and SMPTE RP 125 allow analog luminance bandwidth of 5.5 MHz and chrominance bandwidth of 2.75 MHz for standard definition video. 1080-line HD has a luminance bandwidth of 30 MHz (ITU-R BT.709).

Digital image systems generally require large bandwidths hence the reason why many storage and transmission systems revert to compression techniques to accommodate the signal.

Bayer filter/mask array



A Bayer array is a pattern of red, green and blue non co-sited filters placed onto an imaging chip (CCD, CMOS) so that it can capture the separate red, blue and green primary colors of the image to make up a color digital image. As our eyes have more resolution for green light than red or blue, there are twice as many green cells as there are red and blue. Some redundancy of the green pixels produces an image which is less noisy and has finer detail than would be achieved if there were and equal number of red, green and blue cells.

The R, G and B pixels generated by the Bayer filter need to be 'unmasked' using a complex algorithm to produce white.

Traditionally professional TV cameras have used three image sensors, one to pick up each primary color. This arrangement demands that the three are finely registered together and involves a considerably more bulky construction and cost than the still digital cameras and consumer camcorders that use a single chip sensor with a Bayer, or other similar filter. However some new high-end professional cameras now have just one sensor, for example the ARRI D20 and Red.

Best light (pass)
Shot by shot color correction to produce the best result for each shot.

B

Betacam

An analog component VTR system for PAL and NTSC television introduced in 1982, using a half-inch tape cassette – very similar to the domestic Betamax. This was developed by Sony and was marketed by them and several other manufacturers. Betacam records the Y, R-Y and B-Y component signals onto tape; many machines were operated with coded (PAL or NTSC) video in and out. Initially developed for the industrial and professional markets the system was enhanced to offer models with full luminance bandwidth (Betacam SP 1986), PCM audio and SDI connections with a great appeal to the broadcast market.

Digital Betacam – Introduced in 1990 it was a development of the original analog Betacam VTR that records SD component video and audio digitally onto Betacam-style cassettes. It uses mild intra-field compression to reduce the ITU-R BT.601 sampled video data by about 2:1 to provide a good and much cheaper alternative to the uncompressed D1 format.

Betacam SX (1996) was a digital tape recording format which uses a constrained version of MPEG-2 compression at the 4:2:2 profile, Main Level (422P@ML). The compression is 10:1 and uses a 2-frame GOP (one I and one B frame), making it more difficult to edit. It uses half-inch tape cassettes.

See also: MPEG-2

B-frames

See MPEG-2

Binary

Mathematical representation of numbers to base 2, i.e. with only two states, 1 and 0; on and off; or high and low. This is the basis of the mathematics used in digital systems and computing. Binary representation requires a greater number of digits than the base 10, or decimal, system most of us commonly use everyday. For example, the base 10 number 254 is 11111110 in binary.

There are important characteristics which determine good digital video equipment design. For example, the result of a binary multiplication contains the sum of digits of the original numbers. For example:

10101111 x 11010100 = 1001000011101100
(in decimal 175 x 212 = 37,100)

Each digit is known as a bit. This example multiplies two 8-bit numbers and the result is always a 16-bit number. So, for full accuracy, all the resulting bits should be taken into account. Multiplication is a very common process in digital television equipment (e.g. keying, mixes and dissolves).

See also: Bit, Byte, Digital mixing, Dynamic Rounding

B

Bit (b)

Binary digIT = bit

One mathematical bit can define two levels or states, on or off, black or white, 0 or 1 etc.; – two bits can define four levels, three bits eight, and so on: generally 2^n, where n = the number of bits. In image terms 10 bits can be used to define 1024 levels of brightness from black to white (with ITU-R BT.601 and 709, 64 = black and 940 = white).

Note that in both decimal and binary numbers the first digit describes the largest part of the number's value. For example, the base-10 number 254 is 11111110 in binary. In binary the first digit of the number is called the most significant bit (MSB). Likewise the last digit is the least significant bit (LSB).

See also: Byte

Bit rate reduction (BRR)

See Compression

BITC

Burnt-in Timecode. Timecode that is displayed on the video to which it refers. This is often recorded to provide precise frame references for those viewing on equipment not supplied with timecode readers – originally domestic VCRs and these days, QuickTime viewers.

Blocks and Blocking

See MPEG-2

Bluetooth

Short-range, up to 100m, wireless data connection in a Personal Area Network. Bluetooth is used in products such as phones, printers, modems and headsets and is acceptable where two or more devices are in proximity to each other and not needing high bandwidth (2 Mb/s max.). It is easy to set up without configuration as Bluetooth devices advertise all services they provide making using the service easily accessible, without network addresses, permissions and all the other considerations that go with typical networks.

Website: www.bluetooth.com

Blu-ray Disc (BD)

This optical disk can hold 25 GB on a single-layer CD-sized (12cm) disk using 405 nanometer blue-violet lasers. Dual layer disks hold up to 50 GB. The companies that established the basic specifications are: Hitachi Ltd., LG Electronics Inc., Matsushita Electric Industrial Co. Ltd., Pioneer Corporation, Royal Philips Electronics, Samsung Electronics Co. Ltd., Sharp Corporation, Sony Corporation, and Thomson Multimedia.

Players must be able to decode MPEG-2, H.264/AVC (MPEG-4 part 10) and SMPTE VC-1 coded material. MPEG-2 offers backward compatibility for DVDs while the other two more modern codecs are at least 50 percent more efficient, using less disk space or producing higher quality results. Audio codecs supported are Linear PCM, Dolby Digital, Dolby Digital Plus, Dolby TrueHD, DTS Digital Surround, DTS-HD.

The baseline data rate is 36 Mb/s – giving over one-and-a-half hours recording of HD material on a single layer, or about 13 hours of SD. For Blu-ray Disc movies (BD-ROM) the maximum transfer rate is 54 Mb/s for audio and video, with a maximum of 40 Mb/s for video. Random access allows easy video editing and simultaneous record and playback.

The first BD disks were contained in a protective plastic caddy to avoid scratch damage. This made them somewhat bulky so now they are coated with a hard top layer to reduce the possibility of scratch damage and there is no caddy. Blu-ray won the competition with HD DVD.

See also: DVD, HD DVD, Optical disks, Professional Disc
Website: www.blu-raydisc.com

Breaking the frame (Stereoscopic)

Stereo objects in front of the screen plane (negative parallax) are problematic if they intersect the edge of frame, as contradictory depth cues are sent to the viewer. Essentially one cue is saying that the object is in front of the screen and another is saying that the object is behind it.

This problem can be reduced in post production by a technique known as a 'floating window'. This involves applying a partially transparent mask, reducing the strength of the cues on whichever side the object is breaking frame (and simultaneously if there are objects breaking frame both left and right).

Another kind of issue is caused by objects moving backwards and forwards over the edge of frame. As an object moves off the edge of a screen one stereo camera signal is lost before the other. The result is that the stereo signal temporarily 'switches off'. This can sometimes be solved by sizing up both images in post, causing the object to move off screen altogether.

Broadband
General term referring to faster-than-telephone-modem connections, i.e. receiving (download) much faster than 56 kb/s and transmitting (upload) faster than 28 kb/s. Broadband connects subscribers to the internet via DSL or ADSL over the original copper telephone lines. Cable can offer higher data rates. The higher broadband speeds are capable of carrying live digital TV to homes.

See also: ADSL

Browse
Method used with some stills stores, graphics systems and nonlinear editing systems to display a selection of reduced size or reduced resolution images to aid choice of stored clips or stills. For moving video, a timeline may be available so clips can be shuttled allowing the full sized images to be brought to use pre-cued.

Browse/edit facilities are used in newsroom systems to provide video editing for journalists on their desktops. The material is stored on a browse server and distributed over a network to the many users. Details differ between models but some allow frame-accurate shot selections to be made with the resulting 'cuts decision lists' used to conform a broadcast quality version.

Bug
An error in a computer program that causes the system to behave erratically, incorrectly or to stop altogether. Term dates from the original computers with tubes and relays, where real live bugs were attracted by the heat and light and used to get between the relay contacts.

Bus
An internal pathway for sending digital signals from one part of a system to another.

BWF
Broadcast WAV file – an audio file format based on Microsoft's WAV. It can carry PCM or MPEG encoded audio and adds the metadata, such as a description, originator, date and coding history, needed for interchange between broadcasters.

See also: WAV
Website: www.ebu.ch/en/technical/publications/userguides

Byte (B), kilobyte (kB), megabyte (MB), gigabyte (GB), terabyte (TB) and petabyte (PB)

1 Byte (B) = 8 bits (b) which can describe 256 discrete values (brightness, color, etc.).

Traditionally, just as computer-folk like to start counting from zero, they also ascribe 2 raised to the power 10, 20, 30, etc. (2^{10}, 2^{20}, 2^{30}, etc.) to the values kilo, mega, giga, etc. which become, 1,024, 1,048,576, 1,073,741,824, etc. This can be difficult to handle for those drilled only in base-10 mathematics. Fortunately, disk drive manufacturers, who have to deal in increasingly vast numbers, describe their storage capacity in powers of 10, so a 100 GB drive has 100,000,000,000 bytes capacity. Observation suggests both systems are continuing in use... which could lead to some confusion.

Traditional	**New**	**Approx duration** @601	@709 1080/60i	2k
1 kB = 2^{10} bytes = 1,024 B	10^3 B	⅔ line	⅕ line	⅛ line
1 MB = 2^{20} bytes = 1,048,576 B	10^6 B	1 frame	1/5 frame	130 lines
1 GB = 2^{30} bytes = 1.074 x 10^9 B	10^9 B	47 sec	6.4 sec	3.5 sec
1 TB = 2^{40} bytes = 1.099 x 10^{12} B	10^{12} B	13¼ hrs	1¾ hrs	58 mins
1 PB = 2^{50} bytes = 1.126 x 10^{15} B	10^{15} B	550 days	74 days	40 days

Currently 3.5-inch hard disk drives store from about 70 GB to 1 TB. Solid-state store chips, RAMs, increment fourfold in capacity every generation now offering up to 8Gb chips (i.e. 8 x 2^{30}). Flash memory is now used in some camcorders such as Panasonic's P2 series.

A full frame of standard definition digital television, sampled at 10 bits according to ITU-R BT.601, requires around 1 MB of storage (1.037 MB for 576-line, 876 kB for 480-line systems). HDTV frames comprise up to 5 or 6 times more data, and 2K digital film frames sampled in RGB or X´Y´Z´ (DCI colorspace) are about 12 MB.

See also: DCI, DRAM, Disk drives, Storage

Camera negative (film)

Camera negative film is designed to capture as much detail as possible from scenes. This not only refers to its spatial resolution but also its dynamic resolution. Modern camera negative stock has almost 10 stops' exposure range and so is able to record detail in both the low-lights and the highlights which are well beyond the range that can be shown on the final print film. This provides latitude to compensate for over or under exposure during the shoot or to change the look of a scene. The latitude is engineered into the film stock by giving it a very low gamma of around 0.6.

Exposed and developed camera color negative film has an orange tint and is low in contrast – differing greatly from the un-tinted and high contrast print film. As not only the blue, but also the red and green layers of the film are sensitive to blue light, the orange layer is added below the blue layer to stop blue light going further. All types of film stocks use orange dye but for print films it is bleached away during processing.

There are numerous stocks available. High speed stocks work well in lower lights but tend to be more grainy. The opposite is true for low speed stocks.

Cardboarding (Stereoscopic)

Lack of true 3D feel to a shot making it look like it is made from cardboard cutouts. This is also referred to as Cutout Planar Effect. Caused by inadequate depth resolution due to an incorrect matching between the focal length of the recording lens (or CGI camera) and the interocular distance between the cameras.

See also: Interocular

CCD

Charge Coupled Device (CCD) – either assembled as a linear or two-dimensional array of light sensitive elements. Light is converted to an electrical charge in a linear fashion – proportional to the brightness impinging on each cell. The cells are coupled to a scanning system which, after analog to digital conversion, presents the image as a series of binary digits.

Early CCD arrays were unable to work over a wide range of brightness but they now offer low noise, high resolution imaging up to HDTV level and for digital cinematography.

See also: CMOS

CCIR

Comité Consultatif International des Radiocommunications. This has been absorbed into the ITU under ITU-R.

See also: ITU

CCITT
International Telegraph and Telephone Consultative Committee. As the name suggests this was initially set up to establish standards for the telephone industry in Europe. It has now been superseded by ITU-T so putting both radio frequency matters (ITU-R) and telecommunications under one overall United Nations body.

See also: ITU

CDL
See: Color decision list

Checksum
A simple check value of a block of data intended to recognized when data bits are wrongly presented. It is calculated by adding all the bytes in a block. It is fairly easily fooled by typical errors in data transmission systems so that, for most applications, a more sophisticated system such as CRC is preferred.

See also: CRC

Chroma keying
The process of overlaying one video signal over another, the areas of overlay being defined by a specific range of color, or chrominance, on the background signal. For this to work reliably, the chrominance must have sufficient resolution, or bandwidth. PAL or NTSC coding systems restrict chroma bandwidth and so are of very limited use for making a chroma key which, for many years, was restricted to using live, RGB camera feeds.

An objective of the ITU-R BT.601 and 709 digital sampling standards was to allow high quality chroma keying in post production. The 4:2:2 sampling system allows far greater bandwidth for chroma than PAL or NTSC and helped chroma keying, and the whole business of layering, to thrive in post production. High signal quality is still important to derive good keys so some high-end operations favor using RGB (4:4:4) for keying – despite the additional storage requirements. Certainly anything but very mild compression tends to result in keying errors appearing – especially at DCT block boundaries.

Chroma keying techniques have continued to advance and use many refinements, to the point where totally convincing composites can be easily created. You can no longer see the join and it may no longer be possible to distinguish between what is real and what is keyed.

See also: Color space, Digital keying, Photo-real

C

Chrominance

The color part of a television signal, relating to the hue and saturation but not to the brightness or luminance of the signal. Thus pure black, gray and white have no chrominance, but any colored signal has both chrominance and luminance. Although imaging equipment registers red, blue and green television pictures are handled and transmitted as U and V, Cr and Cb, or (R-Y) and (B-Y), which all represent the chrominance information of a signal, and the pure luminance (Y).

See also: YUV, Y,Cr,Cb, Composite

CIE

International Commission on Illumination (Commission Internationale de l'Eclairage) is devoted to international cooperation and exchange of information among its member countries on all matters relating to the science and art of lighting. It is a technical, scientific and cultural, non-profit autonomous organization that has grown out of the interests of individuals working in illumination. It is recognized by ISO as an international standardization body.

See also: X´ Y´ Z´
Website: www.cie.co.at/cie

CIF

See Common Image Format

CIFS

Common Internet File System – is a platform-independent file sharing system that supports rich, collaborative applications over the internet which could be useful for collaborative post workflows. It defines a standard remote file-system access protocol, enabling groups of users to work together and share documents via the Internet or within intranets. CIFS is an open, cross-platform technology based on native file-sharing protocols in Windows and other popular PC operating systems, and is supported on other platforms, so users can open and share remote files on the Internet without installing new software or changing work methods.

CIFS allows multiple clients to access and update the same file, while preventing conflicts with sophisticated file-sharing and locking semantics. These mechanisms also permit aggressive caching and read-ahead/write-behind without loss of cache coherency. CIFS also supports fault tolerance in the face of network and server failures.

In Quantel's Genetic Engineering teamworking infrastructure, the Sam data server virtualizes media on-the-fly to give third-party applications instant access to all stored media using the CIFS protocol for no-API, out-of-the-box connectivity.

Website: www.microsoft.com/mind/1196/cifs.asp

C

CineAlta
Sony brand for products designed for the digital cinematography market.

See also: HDCAM

Cineon (file)
An RGB bitmap file format (extension .cin) developed by Kodak and widely used for storing and transferring digitized film images. It accommodates a range of film frame sizes and includes up to full Vista Vision. In all cases the digital pictures have square pixels and use 10-bit log sampling. The sampling is scaled so that each of the code values from 0-1023 represents a density difference of 0.002 – describing a total density range of 2.046, equivalent to an exposure range of around 2,570:1 or about 11.3 stops. Note that this is beyond the range of current negative film.

The format was partly designed to hold virtually all the useful information contained in negatives and so create a useful 'digital negative' suitable as a source for post production processing and creating a digital master of a whole program.

See also: 10-bit log, DPX

Clip
The name is taken from the film industry and refers to a segment of sequential frames made during the filming of a scene. In television terms a clip is the same but represents a segment of sequential video frames. In Quantel editing systems, a clip can be a single video segment or a series of video segments spliced together. A video clip can also be recorded with audio or have audio added to it.

Clone
An exact copy, indistinguishable from the original. As in copying recorded material, eg copy of a non-compressed recording to another non-compressed recording. If attempting to clone compressed material care must be taken not to decompress it as part of the process or the result will not be a clone.

Codec
Originally short for a combination of a coder and decoder but now often used to describe just one or the other. Mostly codec refers to a compression coder or decoder such as JPEG, MPEG or JPEG 2000.

Coded (video)
See Composite

C

COFDM

Coded Orthogonal Frequency Division Multiplexing – a modulation scheme which is used by the DVB digital television system. It allows for the use of either 1705 carriers (usually known as '2K'), or 6817 carriers ('8K'). Concatenated error correction is used. The '2K' mode is suitable for single transmitter operation and for relatively small single-frequency networks with limited transmitter power. The '8K' mode can be used both for single transmitter operation and for large area single-frequency networks (SFN). The guard interval is selectable. The '8K' system is compatible with the '2K' system. Initially only 2K was possible but now 8K is more normal.

There has been much discussion about the relative merits of COFDM vs the 8-VSB scheme used in the ATSC standard. The Japanese ISDB system uses a similar scheme, OFDM, and the Chinese have developed their own transmission scheme the DMB-T/H standard – not to be confused with the T-DMB Korean standard modulation – both radically different COFDM implementations.

See also: DVB, ISDB, VSB
Website: www.dvb.org
www.dmb.cn

Color correction

See Grading

Color cube

A representation of color space by a three-dimensional diagram. For example, all definable colors of an RGB color space can be contained in an RGB color cube where R, G and B are axes at right angles to each other (like x, y and z at the corner of a cube). Different color spaces and interpretations of color are defined by different color cubes.

If the exact spectral values of R, G and B are defined, that cube defines an absolute color space. Such cubes are available from a number of vendors.

Color Decision List (CDL)

The American Society of Cinematographers' Color Decision List (ASC-CDL) is a proposed metadata interchange format for color correction, developed to ensure that images appear the same when displayed in different places and on different platforms. This should enable consistency of look from on-set monitoring through post production to the final grade.

Color management

The control of color through a defined process. The idea is that all, or at least some, pictures, monitors or screens should portray the colors as they will appear when shown in their target medium. For example, if working on a DI project, the color management should ensure that the monitors show the colors exactly as an audience in a cinema will see them. Today that may be by use of a release print, in which case the color management has to adjust the monitoring for the film stock to be used. It could also be from a digital cinema distribution master (DCDM) and the color characteristics of that path taken into account as part of the color management.

Color space

The color range between specified references. Typically three references are quoted in television: for example RGB, Y R-Y B-Y and Hue, Saturation and Luminance (HSL) are all color spaces. In print, Cyan, Magenta, Yellow and Black (CMYK) are used. Film is RGB while digital cinema uses X´Y´Z´. Moving pictures can be moved between these color spaces but it requires careful attention to the accuracy of processing involved. Operating across the media – print, film and TV, as well as between computers and TV equipment – will require conversions in color space.

Electronic light sensors detect red, blue and green light but TV signals are usually changed into Y, R-Y and B-Y components at, or very soon after they enter the electronic realm via camera, scanner or telecine. There is some discussion about which color space is best for post production – the most critical area of use being keying. However, with most video storage and infrastructure being component-based, the full RGB signal is usually not available so any of its advantages can be hard to realize for television-based productions. However, in the rapidly growing Digital Intermediate process, where film 'post production' is handled digitally, RGB color space predominates.

The increasing use of disk storage, networking able to carry RGB and digital cameras with RGB outputs RGB infrastructure and operations are more widely used. Even so, RGB takes up 50 percent more storage and, for most productions, its benefits over component working are rarely noticed. One area that is fixed on RGB use is in 2K and 4K digital film (digital intermediates). Modern digital techniques allow the use of both RGB and Y R-Y B-Y to best suit production requirements.

See also: 2K, Keying

C

Color Transform Language (CTL)

Color Transformation Language is a small programming language designed to serve as a building block for digital color management systems. It allows users to describe color transforms in a concise and unambiguous way by expressing them as programs that describe the transform that can be applied to pixel data. It is designed to run fast, operating on many pixels at one time.

See also: OpenEXR
Website: http://ampasctl.sourceforge.net

Convergence (Stereoscopic)

In human eyesight, convergence is the ability of our eyes to divert eye optical axes horizontally in an inward direction. The convergence 'near point' is the closest point which is still possible to perceive one image. In practice, the eyes can easily converge inward but have much less ability to diverge outward, as it is something we don't do in life and only when looking at 3D images that have positive parallax beyond the individual human interocular.

In cameras – 'toeing' of the cameras (to simulate the eyes converging) to focus on a depth point in the scene, either in front of, behind or at the point of interest. The 'convergence point' is where the axes of toed in cameras align on the Z-axis. Convergence can be adjusted in post production by horizontal movement. Note that sometimes the term 'vergence' is used to describe both convergence and divergence.

Convergence pullers are camera-crew members on a Stereoscopic shoot who are responsible for setting up and shifting the convergence during a shot.

See also: Parallax

C-mode

In videotape editing, operating in C-mode allows the shots on the source footage reels to be copied to the edit tape in the order they are recorded on the source tapes, rather than the order required for the finished program. So all the selected material from a source reel can be copied before loading another source reel – thus saving spooling and reel changing time. This assumes that none of the edits will need to be changed along the way!

The term lives on in the disk-based editing world as the editing disk store can randomly access the footage recorded from the source tape. So C-mode editing on disks not only gives the advantages of faster and more convenient transfers but the edits can be more easily altered in a disk store's random access environment.

CMOS

Complementary metal–oxide–semiconductor technology very widely used to manufacture electronic integrated circuits (chips). CMOS chip digital applications include microprocessors, RAM memory and microcontrollers. There are also a wide variety of analog applications.

CMOS devices are favored for their immunity to high levels of noise, low static power drain, with significant power only drawn while the transistors switch, and high density packing of logic functions. Being so widely used, the technology is relatively cheap to manufacture.

Recently the application of CMOS technology to image sensors has increased. The chips are cheaper than the alternative CCDs, they consume less power, can be more sensitive (faster), have less image lag and can include image-processing functions on the sensor chip. Later developments are aimed at improving performance in the areas of noise, dynamic range and response.

Color management

The management of color through a process – such as DI or video grading. Television engineering folklore says that a picture never looks exactly the same on two picture monitors. Certainly it has been hard to achieve a convincing match… until now. By the use of probes to measure the colors on a screen, and equipment with adjustable color LUTs, the look of color can be set to the same across all monitors – within their technical limits. Such care is needed in DI where grading is a big part of the process. Today DI suites may be equipped with a digital projector and large screen. The look of colors on the screen can be set to match those expected for a chosen print stock, so the DoP and grader can see the footage exactly as it will look in the cinema, or other chosen audience. This is color management. A point to watch is that each stage of the workflow is set to unity, so that one does not attempt to compensate for another.

See also: WYSIWYG, X´ Y´ Z´

Color timing (a.k.a. Grading)

The color of film exposed and processed in a laboratory is controlled by separately altering the amount of time that the red, blue and green lights are used to expose the film. This is referred to as color timing and its effect is to alter contrast of R, G and B to create a required color balance.

In a lab, color timing is usually applied at the point where the edited negative is copied to the master interpositive but can be done later at other points if required. In the digital film process, color timing is applied at any required time, as required. In addition there is far more flexibility for color control with gamma, hue, luminance, saturation as well as secondary color correction. In addition, the results can be seen immediately and projected onto a large cinema screen and further adjusted if required. The images have precise color settings to show the results as if output via film, or digitally.

See also: Grading, Lights, Timing

C

Common Image Format (CIF)

The ITU has defined common image formats. A standard definition image of 352 x 240 pixels is described for computers. For HDTV production the HD-CIF preferred format is defined in ITU-R BT.709-4 as 1920 x 1080, 16:9 aspect ratio with progressive frame rates of 24, 25 and 30 Hz (including segmented) and interlace field rates of 50 and 60 Hz. This has helped to secure the 1920 x 1080 format as the basis for international program exchange.

See also: ITU-R BT.709

Component video

The normal interpretation of a component video signal is one in which the luminance and chrominance remain as separate components, e.g. analog components in Betacam VTRs, digital components Y, Cr, Cb in ITU-R BT.601 and 709. RGB is also a component signal. Pure component video signals retain maximum luminance and chrominance bandwidth and the frames are independent of each other. Component video can be edited at any frame boundary.

See also: Cut (edit)

Composite video

Luminance and chrominance are combined along with the timing reference sync and color burst information using one of the coding standards – NTSC, PAL or SECAM – to make composite video. The process, which is an analog form of video compression, restricts the bandwidths (image detail) of the color components. In the composite result color is literally added to the monochrome (luminance or Y) information using a visually acceptable technique. As our eyes have far more luminance resolving power than for color, the color sharpness (bandwidth) of the coded signal is reduced to well below that of the luminance. This provides a good solution for transmission and viewing but it becomes difficult, if not impossible, to accurately reverse the process (decode) back into pure luminance and chrominance. This limits its use in post production as repetitive decode, recode cycles severely impair the pictures. Deriving keys from composite video gives poor results.

See also: $4f_{sc}$, D2, D3

Compositing

Multi-layering for moving pictures. Modern composites often use many techniques together, such as painting, retouching, rotoscoping, keying/matting, digital effects and color correction as well as multi-layering to create complex animations and opticals for promotions, title sequences and commercials as well as in program content. Besides the creative element there are other important applications for compositing equipment such as image repair, glass painting and wire removal – especially in motion pictures.

The quality of the finished work, and therefore the equipment, can be crucial especially where seamless results are demanded. For example, adding a foreground convincingly over a background – placing an actor into a scene – without any telltale blue edges or other signs that the scene is composed.

See also: Digital keying, Photo-real

Compression (audio)

Reduction of bandwidth or data rate for audio. Many digital schemes are in use, all of which make use of the way the ear hears (e.g. that a loud sound will tend to mask a quieter one) to reduce the information sent. Generally this is of benefit in areas where bandwidth or storage is limited, such as in delivery systems to the home, handheld players, etc.

See also: Auditory masking, Dolby Digital

Compression (video)

The process of reducing the bandwidth or data rate of a video stream. The analog broadcast standards used today, PAL, NTSC and SECAM are, in fact, compression systems which reduce the information contained in the original RGB sources.

Digital compression systems analyze their picture sources to find and remove redundancy both within and across picture frames. The techniques were primarily developed for digital data transmission but have been adopted as a means of reducing broadcast transmission bandwidths and storage requirements on disks and VTRs.

A number of compression techniques are in regular use for moving images. These include ETSI, JPEG, Motion JPEG, JPEG 2000, DV, MPEG-1, MPEG-2, MPEG-4, AVC Intra, Windows Media and Real. Where different techniques are used in the same stream, problems can occur and picture quality can suffer more than if the same method is used throughout.

The MPEG-2 family of compression schemes, which was originally designed for program transmission, has been adapted for studio use in Betacam SX and IMX recorders.

While there is much debate, and new technologies continue to be developed, it remains true that the best compressed results are produced from the highest quality source pictures. Poor inputs do not compress well. Noise, which may be interpreted as important picture detail, is the enemy of compression.

See also: Compression ratio, Concatenation, Digital Betacam, ETSI, JPEG, JPEG 2000, MPEG-2, MPEG-4, Windows Media

C

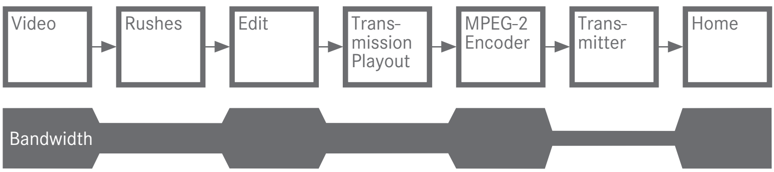
Compression ratio

The ratio of the amount of data in the non-compressed digital video signal to the compressed version. Modern compression techniques start with component television signals but a variety of sampling systems are used, 4:2:2 ('Studio' MPEG-2), 4:2:0 (MPEG-2), 4:1:1 (NTSC, DVCPRO), etc. The compression ratio should not be used as the only method to assess the quality of a compressed signal. For a given technique, greater compression can be expected to result in lower picture quality but different techniques give widely differing quality of results for the same compression ratio. The more modern technologies, MPEG-4 (H 264), VC-1, and JPEG 2000 are more efficient than MPEG-2. The only sure method of judgment is to make a very close inspection of the resulting pictures – where appropriate, re-assessing their quality after onward video processing.

See also: Concatenation, DV, ETSI, JPEG, JPEG 2000, MPEG

Concatenation

The linking together of systems in a linear manner. In digital television this often refers to the concatenation of compression systems which is a subject of concern because any compression beyond about 2:1 results in the removal of information that cannot be recovered. As the use of compression increases, so too does the likelihood that material will undergo a number of compressions between acquisition and transmission. Although the effects of one compression cycle might not be very noticeable, the impact of multiple decompressions and recompressions – with the material returned to baseband in between – can cause considerable damage. The damage is likely to be greatest where different compression schemes are concatenated in a particular signal path.



Conform

Cutting together recorded material according to a prepared scheme such as a rough cut or EDL. EDLs can be used to directly control conforming in an online edit suite (auto-conforming). The time to conform varies widely, from a tape-based suite which takes much longer than the finished program's running time, to a nonlinear online suite with true random access to all material. This reduces time by loading material in C-mode and the conforming itself takes only a moment and still allows any subsequent adjustments to be easily made.

Note that with in-server editing, material may be loaded onto the server as an independent task, rather than involving the edit equipment itself. This circumvents the loading time so further reducing the total time to produce the finished program. The same is also true of nonlinear edit systems with the bandwidth to support loading as a background task.

There are a number of established ways, or modes, of approaching video editing.

A-mode is a simple sequential method, starting from the beginning of the program and going through to the end.

B-mode uses all shots from one particular source before the next source is used (i.e. checkerboarding).

C-mode is similar to B-mode but works sequentially through the playback source rather than the record tape.

D-mode is similar to A-mode except that dissolves and other transitions are performed last, at the end of the conform.

E-mode is similar to C-mode but with transitions at the end, as in D-mode.

Note that the logic of the above modes is based on the characteristics of videotape. As tape is increasingly replaced by other recording media, network conform is becoming increasingly used. Part of the work of the Advanced Media Workflow Association (AMWA) is to provide new industry standards for this important area.

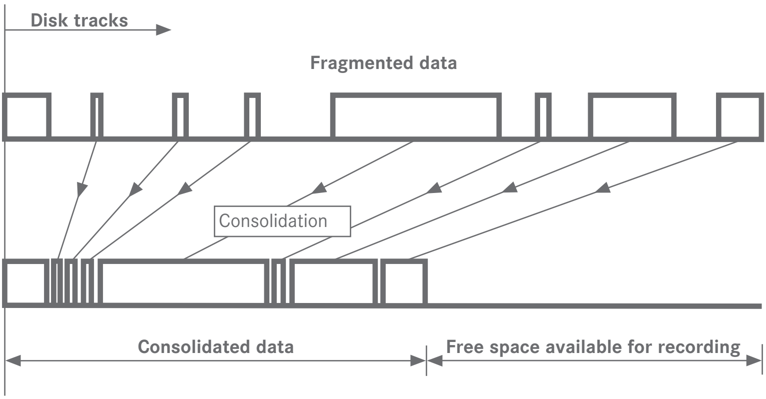
See also: Background loading, Delta editing, In-server editing, Uncommitted editing
Website: www.aafassociation.org

C

Consolidation

Clearing continuous space on a disk store to allow consistent recording. This generally involves the moving of data on the disks to one area, leaving the remainder free so that recording can proceed track-to-track – without having to make random accesses. The larger the amount of data stored, the longer consolidation may take. Careful consideration must be given to large-capacity multi-user systems, such as video servers, especially when used for transmission or on-air.

The need for consolidation arises because of the store's inability to continuously record television frames randomly at video rate. This is taken care of by Quantel's FrameMagic. Recording can take place over small, scattered areas of the store so there is no need for consolidation.



See also: Defragmentation, FrameMagic, True random access

Constant bit rate (CBR) compression

Compression systems that are used to create a fixed rate of output data. This is usually to fit within a given bandwidth such as that available on a video tape recorder or a constant bit rate transmission channel. With video, the amount of useful information contained in the material varies widely both spatially and temporally – with movement. For example, a football match with crowds and grass texture as well as fast panning cameras typically contains far more information than a largely static head-and-shoulders shot of a newsreader. Using constant bit rate means that the quality is altered to reduce the information to fit the fixed bit rate. In the football case, the grass may go flat during a camera pan, with the texture suddenly reappearing when the camera is still.

As overflowing the available bit rate could have disastrous results with bits being lost, the aim is always to use just under the available bit rate. The degree of success in almost filling the available space (not easily done live) is a measure of the quality and efficiency of the compression system.

See also: Variable bit rate

Content

Pictures, sound, text, graphics, etc., that are edited and ready for delivery to customers – typically as programs for television.

See also: Essence

Contouring

An unwanted artifact similar to posterization. Digital video systems exhibit contouring when insufficient quantizing levels or inaccurate processing are used, or poor truncation occurs. The result is that the picture's brightness changes in steps that are too large and become visible over relatively even-brightness areas – like the sky.

See also: Dynamic Rounding

Control track

A linear track recorded onto videotape at frame frequency as a reference for the running speed of a VTR, for the positioning or reading of the video tracks and to drive a tape counter. It is a magnetic equivalent of sprocket holes in film. One of the main purposes of 'striping' tapes is to record a continuous control track for the pictures and audio to be added later – as in insert editing. Control tracks are not used in disk recording and nonlinear editing.

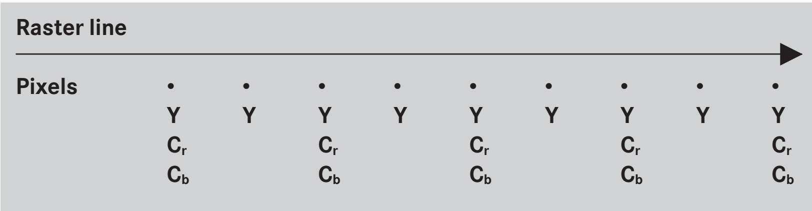
Corner pinning

A technique for controlling the position and rotation of pictures in a DVE by dragging their corners to fit a background scene: for example, to fit a (DVE) picture into a frame hanging on a wall. Corner pinning was developed by Quantel as a practical alternative to precisely setting the many parameters needed to accurately position a picture in 3D space.

This works well with graphical user interfaces, e.g. pen and tablet. It can also be combined with the data derived from four-point image tracking to substitute objects in moving images, for example replacing the license plate on a moving vehicle.

See also: Tracking

Co-sited sampling
This is a sampling technique applied to color difference component video signals (Y, Cr, Cb) where the color difference signals, Cr and Cb, are sampled at a sub-multiple of the luminance, Y, frequency – for example as in 4:2:2. If co-sited sampling is applied, the two color difference signals are sampled at the same instant, and simultaneously with a luminance sample. Co-sited sampling is the 'norm' for component video as it ensures the luminance and the chrominance digital information is coincident, minimizing chroma/luma delay.



4:2:2 Co-sited sampling

CRC
Cyclic Redundancy Check – an advanced checksum technique used to recognize errors in digital data. It uses a check value calculated for a data stream by feeding it through a shifter with feedback terms 'EXORed' back in. It performs the same function as a checksum but is considerably harder to fool.

A CRC can detect errors but not repair them, unlike an ECC. A CRC is attached to almost any burst of data which might possibly be corrupted. On disks, any error detected by a CRC is corrected by an ECC. ITU-R BT.601 and 709 data is subjected to CRCs. If an error is found the data is concealed by repeating appropriate adjacent data. Ethernet packets also use CRCs.

See also: Asynchronous, Checksum, ECC, EXOR

Cross conversion
Changing video material from one HD format to another. For example, going from 720/60P to 1080/50I is a cross conversion. Note that this example involves both changing picture size and the vertical scan rate from 60 Hz progressive to 50 Hz interlaced. Similar techniques are used as for standards conversion but the HD picture size means the processing has to work five or six times faster.

See also: Down-res, Frame-rate conversion, Standards conversion, Up-res

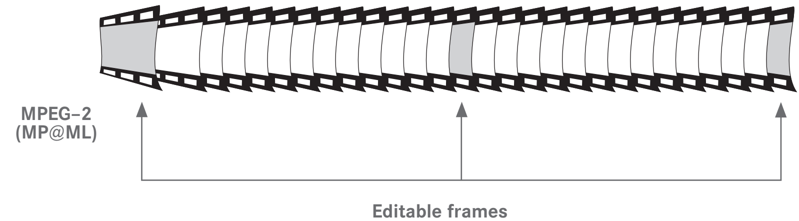
CSMA/CD
See: Ethernet

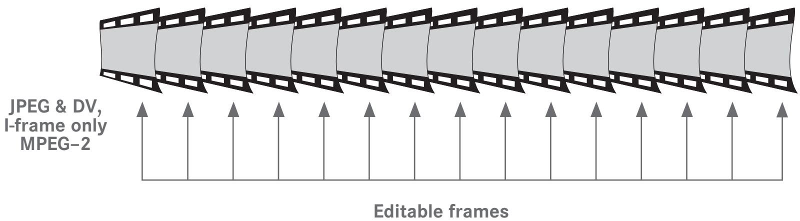
Cut (edit)

A transition at a frame boundary from one clip or shot to another. On tape a cut edit is performed by recording (dubbing) the new clip at the out-point of the last, whereas with FrameMagic's true random access storage no re-recording is required – there is simply an instruction to read frames in a new order. Simple nonlinear disk systems may need to shuffle, or de-fragment their recorded data in order to achieve the required frame-to-frame access for continuous replay.

The editable frame boundaries may be restricted by video coding systems such as MPEG-2, MPEG-4, VC-1, etc. Non-compressed component video and that is compressed using I-frame only compression (e.g. DV, motion JPEG, motion JPEG 2000 or I-only MPEG-2) can be edited on any frame boundary without additional processing.

See also: Fragmentation, I-frame only





D1

A format for digital video tape recording working to the ITU-R BT.601, 4:2:2 standard using 8-bit sampling. The tape is 19 mm wide and allows up to 94 minutes to be recorded on a cassette.

Introduced in 1986, Sony's D1 VTR set a benchmark as it was the first uncompressed component digital tape format. It offered very high quality, only small degradation over many re-record generations and, with its high chrominance bandwidth, allowed excellent chroma keying. Despite the advantages, D1 use was limited by high cost and is rarely found today. However the term 'D1' is still occasionally used to imply uncompressed component digital recording – 'D1' quality.

See also: D2, DVTR

D2

A VTR standard for digital composite (coded) PAL or NTSC signals. It uses 19 mm tape and records up to 208 minutes on a single cassette. Neither cassettes nor recording formats are compatible with D1. Being relatively costly and not offering the advantages of component operation the format has fallen from favor. VTRs have not been manufactured for many years.

See also: Component, D1, D3, DVTR

D3

A VTR standard using half-inch tape cassettes for recording digitized composite (coded) PAL or NTSC signals sampled at 8 bits. Cassettes record 50 to 245 minutes. Since this uses a composite PAL or NTSC signal, the characteristics are generally as for D2 except that the half-inch cassette size allowed a full family of VTR equipment to be realized in one format, including a camcorder. D3 is rarely used today.

D4

There is no D4. Most DVTR formats hail from Japan where 4 is regarded as an unlucky number.

D5

A VTR format using the same cassette as D3 but recording uncompressed component signals sampled to ITU-R BT.601 recommendations at 10-bit resolution. With internal decoding, D5 VTRs can play back D3 tapes and provide component outputs.

D5 offers all the performance benefits of D1, making it suitable for high-end post production as well as more general studio use. Besides servicing the current 625 and 525 line TV standards the format extends to HDTV recording by use of about 4:1 compression (HD-D5).

D6

A little used digital tape format which uses a 19mm helical-scan cassette tape to record non-compressed HDTV material. The Thomson VooDoo Media Recorder is the only VTR based on D6 technology. The format has passed into history.

D7

This is assigned to DVCPRO.

D9

This is assigned to Digital-S.

D10

This refers to Sony's MPEG IMX VTRs that record I-frame only 4:2:2-sampled MPEG-2 SD video at 50 Mb/s onto half-inch tape. In bit rate, this sits IMX between Betacam SX and Digital Betacam. There is a Gigabit Ethernet card available which has caused some to dub it the eVTR as it can be considered more as a 'storage medium' for digital operations.

D11
The HDCAM VTR format has been assigned D11.

D12
This is assigned to DVCPRO HD.

D-20
A film-style digital camera from Arri that is highly modular and uses a single Super 35mm-sized image CMOS sensor with a Bayer filter and producing the same field of view and depth of field as that of traditional 35mm film motion picture cameras. Like real film cameras it uses a detachable optical viewfinder – that is widely preferred to electronic versions on other cameras. It is capable of 1-60Hz frame rates, produces 1080-line images in 4:2:2 or 4:4:4.

Website: www.arri.com

DAS
Direct Attached Storage, typically on hard disks, is available only to a single user as opposed to NAS that can be available to everyone on the network. Typically this uses SCSI, SAS or Fibre Channel protocol and provides add-on storage for servers that maintains high data rate and fast access.

Data carousel
This is a file system that rotates and delivers its content into a network at a defined point in a cycle – for example, teletext pages. It is a method to make a large amount of information or data files available within a reasonably short time after a request. The data is inserted into the digital broadcast transport stream.

See also: IP over DVB

Data scanner
Sometimes used as a generic term for film scanner.

Data recorders
Machines designed to record and replay data. They usually include a high degree of error correction to ensure that the output data is absolutely correct and, due to their recording format, the data is not easily editable. These compare with digital video recorders which will conceal missing or incorrect data by repeating adjacent areas of picture and which are designed to allow direct access to every frame for editing. Where data recorders are used for recording video there has to be an attendant 'workstation' to produce signals for video and audio monitoring, whereas VTRs produce the signals directly. Although many data recorders are based on VTRs' original designs, and vice versa, VTRs are more efficient for pictures and sound while data recorders are most appropriate for data. They are useful for archiving and, as they are format-independent, can be used in multi-format environments.

See also: DTF, LTO

Datacasting
Broadcasting data.

See: IP over DVB

dB
See Decibel

DC28
SMPTE Task Force On Digital Cinema – intended to aid digital cinema development by determining standards for picture formats, audio standards and compression, etc.

DCI
Digital Cinema Initiatives, LLC was formed in 2002 with members including Disney, Fox, MGM, Paramount, Sony Pictures Entertainment, Universal and Warner Bros. Studios. Its purpose was to establish and document specifications for an open architecture for Digital Cinema components that ensures a uniform and high level of technical performance, reliability and quality control. It published the Digital Cinema System Specification in July 2005 (freely available at their website) establishing a set of technical specifications that have allowed the industry to move forward and start a large-scale roll-out of Digital Cinema.

There are three levels of images, all with a 1:1 pixel aspect ratio, 12-bit 4:4:4 sampling in X´Y´Z´ color space.

Level	Picture size	Aspect ratio	Frame rate
1	4096 x 2160	1.896	24 Hz
2	2048 x 1080	1.896	48 Hz
3	2048 x 1080	1.896	24 Hz

The specification includes requirements for JPEG 2000 image compression, X´Y´Z´ color space and a maximum playout bit rate of 250 Mb/s. To prevent piracy by copying the media files there is AES 128 encryption (Advanced Encryption Standard able to use keys of 128, 192, and 256 bits to encrypt and decrypt data in blocks of 128 bits). There is also forensic marking to deter and trace the bootlegger's camcorder pointed at the screen. Such schemes include Philips' forensic watermarking or Thomson's NexGuard watermarking.

DSM ' DCDM ' DCP ' DCDM* ' Image and Sound

DCI describes a workflow from the output of the feature post production or DI, termed the Digital Source Master (DSM), to the screen. The Digital Cinema Distribution Master (DCDM) is derived from the DSM by a digital cinema post production process, and played directly into a digital cinema projector and audio system for evaluation and approval.

The approved DCDM is then compressed, encrypted and packaged for distribution as the Digital Cinema Package (DCP). At the theater, it is unpackaged, decrypted and decompressed to create a DCDM* with images visually indistinguishable from those of the original DCDM.

Website: www.dcimovies.com

D

DCDM
See DCI

DCP
See DCI

DC-SDI
An HD SDI dual link arrangement that is configured to carry live uncompressed DCI-sized 2K footage. That is 2048x1080 pixel images at 24P, with 12-bit 4:4:4 sampling in X´Y´Z´ color space. This involves a constant data rate of at least 1913 Mb/s, too much for a single HD-SDI, designed for 1080/60I/30P 10-bit 4:2:2 bit rate of 1248 Mb/s and audio. Hence the use of a dual link.

See also: Dual link

DCT (compression)
Discrete Cosine Transform – as a basic operation of MPEG video compression it is widely used as the first stage of compression of digital video pictures. DCT operates on blocks (hence DCT blocks) of the picture (usually 8 x 8 pixels) resolving them into frequencies and amplitudes. In itself DCT may not reduce the amount of data but it prepares it for following processes that will. Besides MPEG, JPEG, VC9, WM9 and DV compression depend on DCT. The use of blocks can lead to blocks being visible on screen where data rates that are too low are used.

See also: DV, ETSI, JPEG, MPEG-2, MPEG-4, Wavelet

Decibel (dB)
Units of measurement expressing ratios of power that use logarithmic scales to give results related to human aural or visual perception. Many different attributes are given to a reference point termed 0 dB – for example a standard level of sound or power with subsequent measurements then being relative to that reference. Many performance levels are quoted in dB – for example signal to noise ratio (S/N).

Decibels are given by the expression:

$$10 \log_{10} P_1/P_2$$

where power levels 1 and 2 could be audio, video or any other appropriate values.

D

Defragmentation

See Fragmentation

Delta editing

A Quantel term for a form of server-based nonlinear editing where only the change information – the EDL along with the any new video frames and audio created in the editing process – are sent back to the server from a connected edit station. For cuts-only editing, the stored result would simply be an EDL. If transitions are created, such as dissolves, wipes, DVE moves etc, these represent new frames that are processed by the editing workstation and sent to the server to be included as a part of EDL. Delta editing contrasts with dub editing or some NLE technology where every frame in the final edit has to be copied to a new file.

See also: FrameMagic

Deliverables

Material that is delivered for use by customers – TV channels, agencies, Web, DVD, mobile phones, etc. The business of making deliverables has expanded with the widening of the scope of digital media. Today it is a considerable business in its own right.

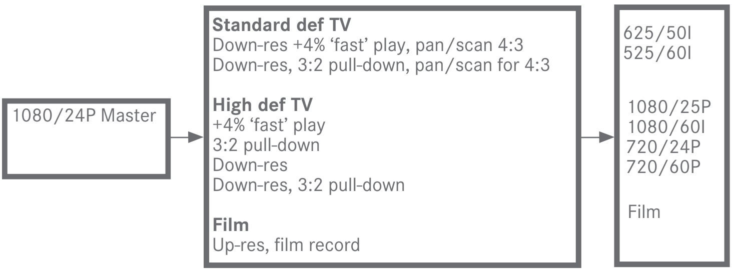
Traditionally deliverables have been made as copies from an edited master of programs and commercials. This process involves replaying the master and recording onto the customers' required storage format D5, DVCPRO, HDCAM, etc. It may also involve other treatments such as pan and scan, color grading and standards conversion from say HD 1920 x 1080/60I to SD 720 x 625/50I. If going to mobile phones that have smaller screens with different aspect ratios and supplied by relatively low bandwidth links, then the treatments such as conversion to a lower frame rate, image re-framing and further removal of image detail may be used.

The 1080/24P or 25 HD format can be used to make high quality versions for any television format, and even for film. This top-down approach preserves quality as the HD image size means any resizing will be downward, making big pictures smaller, rather than up-res'd blow-ups from smaller pictures. For frame rate conversion, over half a century of running movies on TV has established straightforward ways to fast play 24 f/s material to at 25 f/s and to map it to 60 Hz vertical rates using 3:2 pull-down for television.

Combinations of fast play, 3:2 pull-down, down-res and ARC are applied to output the required image format, vertical rate and aspect ratio. For example, fast play of the 1080/24P at 104.16 percent speed produces 1080/25P. Down-res produces 16:9 images in 576 lines and then the 25 progressive frames are read as 50 interlaced frames to create the 576/50I TV. ARC is applied for 4:3 output. Changing from 24P to 60I vertical scans is achieved using 3:2 pull-down.

For film output, a popular image size is 2K. This is only very slightly wider than 1080-line HD (2048 against 1920 pixels per line), and, for digital exhibition, the same 1080 lines is used.

Publishing from a 1080/24P master



But that material may need further editing, for example, a commercial for showing in a different country may require a new soundtrack and text for pricing. There may be censorship issues so shots need adjusting or replacing. Also the growth of digital media platforms means that more work may be required for a wider deliverables market – with escalating numbers of versions required. Some scenes of a digital film master may need re-grading for domestic TV viewing or further processing to fit the bandwidth and screen limitations of mobile viewing. This type of work may be best undertaken with the finished program in uncommitted form, where the source material and all the tools and their settings are available, so that any part of the program can be re-accessed, changed and the whole program re-output exactly as required for the target medium and without compromising the quality of other deliverables.

See also: 3:2 Pull-down, ARC, Down-res, Up-res

Densitometer

An instrument used to measure the density of film, usually over small areas of images. The instrument actually operates by measuring the light passing through the film. When measuring movie film density, two sets of color filters are used to measure Status M density for camera negative and intermediate stocks (orange/yellow-based) and Status A for print film to correctly align with the sensiometric requirements of the stocks.

D

Density

The density (D) of a film is expressed as the log of opacity (O).

$$D = \text{Log}_{10}\, O$$

Using a logarithmic expression is convenient as film opacity has a very wide range and the human sense of brightness is also logarithmic.

See also: Film basics (Tutorial 2)

Depth grading (Stereoscopic)

A post production process where negative and positive parallax convergence are adjusted. This is not only a creative tool used to place objects on the Z axis but also a way to ensure that stereoscopic content can be comfortably watched on the screen size it is intended for. For example, in a post suite the director may be viewing a film on a small projection screen but the final delivery format may be a large theatre or IMAX.

In practice the eyes have little ability to diverge (up to one degree is considered the rule of thumb) and this is especially a consideration in depth grading for very large screens with positive parallax images, where the distance between the left and right representations of an image may be very widely spaced.

Sometimes the term Depth Budget is used to refer to the combined value of positive and negative parallax and expressed as a percentage of screen width.

See also: Parallax

DFS

Distributed File System – used to build a hierarchical view of multiple file servers and shared files on a network. Instead of having to think of a specific machine name for each set of files, users only need to remember one name as the key to a list of shared files on multiple servers. DFS can route a client to the closest available file server and can also be installed on a cluster for even better performance and reliability. Medium-to-large sized organizations are most likely to benefit from using DFS while smaller ones should be fine with ordinary file servers.

DI
See Digital intermediate

Diagnostics
Tests to check the correct operation of hardware and software. As digital systems continue to become more complex, built-in automated testing becomes an essential part of the equipment for tests during both manufacture and operation. This involves some extra hardware and software to make the tests operate. Digital systems with such provisions can often be quickly assessed by a trained service engineer, so speeding repair.

Remote diagnostics can make use of an Internet connection to monitor and test a product at the customer's site while working from a central service base. Thus expert attention can be used immediately on site.

Interdependent multiple systems, such as a video server and its clients, may require simultaneous diagnostics of all major equipment. Here, combining data links from a number of pieces of networked equipment, as with Quantel's R-MON, effectively extends the Remote Diagnostics to larger and more complex situations.

See also: Diagnostics

DiBEG
Digital Broadcasting Experts Group, founded September 1997 to drive the growth of digital broadcasting and international contribution by promoting the exchange of technical information and international co-operation. It is predominantly made up of Japanese manufacturers and the Japanese Ministry of Posts and Telecoms and has produced ISDB, a specification for digital broadcasting in Japan.

See also: ISDB
Website: www.dibeg.org

Digital Asset Management (DAM)
Content is worthless if you cannot find it. If you can find it easily and have rights to use or sell it, it has value. The content will vary in size from a whole movie, to a few frames of news footage. Digital Asset Management (a.k.a. media asset management or digital asset warehousing) is about the storage and use of both digital content and its metadata. The latter comprises descriptions of the content, such as text and thumbnail images, stored in a database for easy searching and management. The metadata is linked to the content files, images or video to allow retrieval.

Digital Betacam

See: Betacam

Digital Cinema

D

Refers to the digital distribution and projection of cinema material. With nearly all films now using the DI process, the next step is to distribute and replay digital material. Thanks to the DCI's Digital Cinema System Specification (July 2005), a set of standards is in place and many thousands of cinemas have already been converted to digital. Installations started in the USA and Europe is following.

The digital cinema chain includes DCI-compliant equipment for mastering which includes JPEG 2000 encoding and encryption, and players and digital film projectors using usually using DLP, D-ILA and other technologies at the cinemas. These allow high quality viewing on large screens. The lack of all-too-familiar defects such as scratches and film weave – even after a few showings – has its appeal. Besides quality issues, D-cinema introduces potential new digital methods of duplication, security and distribution as well as more flexibility in screening. In addition, stereo cinema (a.k.a. 3D) is easy to set up and present using just one 'film' projector (not two), along with a left and right eye selective viewing system. This is having further implications with trials of live 3D events screened in cinemas creating new business models in the media industry.

See also: DCI, DLP-cinema, D-ILA, SXRD

Digital cinematography

Shooting movies with digital cameras – not film. This growing practice generally makes use of cameras designed specifically for the purpose. These differ from the television application in that the full range of brightness captured by the image sensors is offered at the output as raw data, allowing color grading, format changes, etc. to be executed as a part of the digital intermediate process. Television cameras are designed to work live, and so they include front-end processing for gamma correction, set-up for the required color look and clipping to suit home viewing conditions.

The first digital cinematography cameras were adapted from HDTV equipment with maximum image size of 1920 x 1080 and run at 24P. The new generation is built for the cinematography market offering raw data output of wide exposure range images currently up to 4K size or slightly bigger e.g. 4520 x 2540 for the Red One camera.

See also: VFR
Websites: www.panasonic.com/pbds
www.thomsongrassvalley.com/products/cameras/viper
www.red.com
www.arri.com

Digital disk recorder (DDR)

Disk systems that record digital video and generally intended as drop-in replacements for VTRs or as video caches to provide extra digital video sources for far less cost than a DVTR. They have the advantage of not requiring pre-rolls or spooling but they are not necessarily able to randomly access video frames in realtime. DDRs can also offer the higher data rates needed for uncompressed recordings at an economic price – for SD as well as HD and 2K/4K (film) resolutions.

See also: Linear, True random access

Digital intermediate (DI)

The DI refers to the process that accepts exposed video or film footage and eventually delivers edited and graded masters, which either can be internegatives for the production labs to generate large numbers of release prints or as digital masters. Initially the term arose to describe a digital version of the traditional chemical intermediate lab where film is graded, cut and copied from camera negative to several interpositives and then to many internegatives. The internegatives are then distributed to the production labs to make the release prints for cinemas. These processes include creating possibly thousands of release prints from a single set of camera negatives.

Although the boundaries may vary, generally the DI lab accepts developed camera negative, or data from digital movie/HD cameras, and outputs the edited and graded internegative master for a whole or part of a feature. However, the operational and decision-making processes may differ greatly from the traditional film lab, not least because of the interactive nature of the operation. In the DI lab, decisions become on-screen reality and are seen in full context as they are prepared – no waiting for the 'chemical' lab. Grading, dissolves, cuts and effects can be seen immediately and on a big screen – if needed. The interactive process can be more creative and gives complete confidence that the decisions work well. Also grading can take place after the footage is cut together, so the shots are seen, as graded, in context.

The availability of large-scale digital storage means that whole movies can be sent for output to the digital lab's film recorder, exposing 1000ft reels at a time and no final grading required. To help feed the growing number of digital cinemas, the DI lab can produce a DSM (Digital Source Master) – digital cinema's equivalent of internegatives.

D

Digital keying and chroma keying

Digital keying differs from analog chroma keying in that it can key uniquely from any one of the billion colors of component digital video. It is then possible to key from relatively subdued colors, rather than relying on highly saturated colors which can cause color-spill problems on the foreground.

A high quality digital chroma keyer examines each of the three components Y, B-Y, R-Y or R, G, B of the picture and generates a linear key for each. These are then combined into a linear key for the final keying operation. The use of three keys allows much greater subtlety of selection than with a chrominance-only key.

See also: Chroma keying, Keying

Digital lab

A facility where digital intermediate work is carried out.

Digital mixing

Digital mixing requires ‘scaling’ each of two digital signals and then adding them. A and B represent the two TV signals and K the positional coefficient or value at any point of the mix between them (i.e. equivalent to the position of the transition arm on a switcher desk). In a digital system, K will also be a number, assumed here as 10-bit resolution to provide a smooth mix or dissolve.

Mathematically this can be shown as:

A x K = (Mix)1
B x (1-K) = (Mix)2
Result = (Mix)1 + (Mix)2

Note that such math also applies to soft edge keys and any transparency created between two images. As such it is a fundamental part of video processing and good quality results are essential.

When two 10-bit numbers are multiplied together, the result is a 20-bit number (see Binary). When mixing, it is important to add the two 20-bit numbers to obtain an accurate result. This result must then be truncated or rounded to 10 bits for transmission to other parts of the digital system.

Truncation by simply dropping the lower bits of the partial result (Mix)1 or (Mix)2, to 12 bits, or even 14 bits, will introduce inaccuracies. Hence it is important that all partial results, e.g. (Mix)1 and (Mix)2, maintain 20-bit resolution. The final rounding of the result to 10 bits can reveal visible 1-bit artifacts – but these can be avoided with careful rounding techniques such as Dynamic Rounding.

See also: Binary, Dynamic Rounding

Digital negative

Digital image material that contains all the detail (spatial and dynamic/latitude) held in the original camera negative (OCN) film. This allows all latitude headroom to be included on the material for use in a DI process so adjustments of color and exposure can be made to the same degree as with film.

See also: Camera negative

Digital-S

Assigned as D9, this is a half-inch digital tape format which uses a high-density metal particle tape running at 57.8mm/s to record a video data rate of 50 Mb/s. The tape can be shuttled and searched up to x32 speed. Video, sampled at 8 bits, 4:2:2, is compressed at 3.3:1 using DCT-based intra-frame compression. Two audio channels are recorded at 16-bit, 48 kHz sampling; each is individually editable. The format also includes two cue tracks and four further audio channels in a cassette housing with the same dimensions as VHS.

Digitizer

A system which converts an analog input to a digital representation. Examples include analog to digital converters (ADCs) for television signals, touch tablets and mice. Some of these, mouse and touch tablet for example, are systems which take a spatial measurement and present it to a computer in a digital format.

See also: A/D, Into digits (Tutorial 1), GUI

Digitizing time

Time taken to record existing footage into a disk-based editing system. The name suggests the material is being played from an analog source, which it rarely is now. A better term is 'loading'. Use of high-speed networking may enable background loading – eliminating digitizing time at an edit suite.

Digitizing time is often regarded as dead time but it need not be. It can be reduced if some initial selection of footage has been made – for example by logging. Also, footage can be marked while loading and so be instantly available as a rough cut on completion, so speeding the final edit. The process is sometimes referred to as Triage, particularly where it is used to select and pre-edit clips from a live feed.

D

D-ILA

Digital Direct Drive Image Light Amplifier. Technology developed by Hughes-JVC for video projection up to large screen size. The scanned digital images are displayed by a CMOS chip which has a reflective liquid-crystal surface where electronic signals are directly addressed to the image modulator. The image pixel information is addressed to a matrix of 'transistor' cells beneath the liquid crystal. As the liquid crystal responds to voltage level directly, the gray scale is determined by the value of voltage set on each pixel. So the reflection of the projector lamp light focused on the chip produces an image. The technology has been used up to cinema screen size to show digital movies with full 2K (2048 x 1536) QXGA resolution. 3840 x 2048 QHDTV (4 times HD image area) resolution D-ILA chips are at the research stage. These are understood to be capable of projecting 'full 35mm film quality'. This is far beyond today's cinema experience.

Website: www.jvcdig.com/technology.htm

Dirac

See: VC-2

Discrete 5.1 Audio

Often referred to as '5.1', this reproduces six separate (discrete) channels – Left, Center, Right, Left Rear, Right Rear, and sub-woofer (the .1). All the five main channels have full frequency response which, together with a separate low-frequency sub-woofer, create a three-dimensional effect. Discrete 7.1 Audio is similar but includes more speakers.

Discrete 5.1 audio is made available with many HD television broadcasts and is specified on HD DVD and BD media.

See also: Dolby Digital

Disk drives

See Hard disk drive, Optical disks

Display resolutions

The computer industry has developed a series of display resolutions (see below) which span television's SD and HD, and QXGA is identical to the 2K image size used for digital film production*. The availability of hardware to support these resolutions has, and will continue to benefit television and digital film. There is already a QXGA projector on offer.

All use square pixels and none correspond exactly to television formats so attention to size and aspect ratio is needed when using computer images on TV and vice versa.

Type	Size	M Pixels	Aspect ratio	
VGA	640 x 480	0.31	4:3	1.33
SVGA	800 x 600	0.48	4:3	1.33
XGA	1024 x 768	0.79	4:3	1.33
SXGA	1280 x 1024	1.31	4:3	1.33
UXGA	1600 x 1280	2.05	5:4	1.25
WUXGA	1920 x 1200	2.30	16:10	1.60
QXGA	2048 x 1536	3.15	4:3	1.33
QSXGA	2560 x 2048	5.24	4:3	1.33
WQSXGA	3200 x 2048	6.55	16:10	1.56

Notes

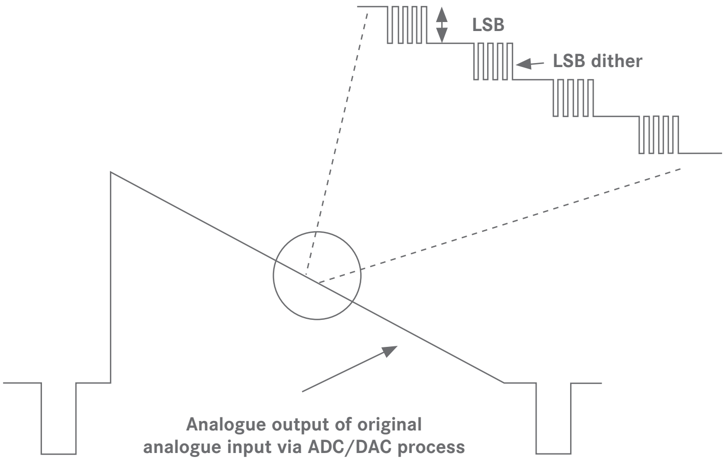
Video SD	720 x 576 (not square pixels)
	720 x 480 (not square pixels)
Video HD	1920 x 1080
2K digital film	2048 x 1556
4K digital film	4096 x 3112
2K DCI cinema	2048 x 1080
4K DCI cinema	4096 x 2160

** The image area of Full Frame film 35 mm images is usually scanned to occupy 2048 x 1536 pixels (4K – 4096 x 3072). The extra 20 (40) lines scan the black strip between successive frames which only carries image information if film is shot with an open gate.*

See also: 2K, Aspect ratio
Website: www.fourmilab.ch/documents/howmanydots

Dither

In digital television, analog original pictures are converted to digits: a continuous range of luminance and chrominance values is translated into a finite range of numbers. While some analog values will correspond exactly to numbers, others will, inevitably, fall in between. Given that there will always be some degree of noise in the original analog signal the numbers may dither by one Least Significant Bit (LSB) between the two nearest values. This has the advantage of providing a means by which the digital system can describe analog values between LSBs to give a very accurate digital rendition of the analog world.



If the image is produced by a computer, or is the result of digital processing, it may have virtually no noise and so the digital dither may not exist – which can lead to contouring effects. With the use of Dynamic Rounding dither can be intelligently added to pictures to give more accurate, better looking results.

DivX

A video codec created by DivX, Inc. which can compress long video segments into relatively small data spaces while maintaining reasonable picture quality. It uses MPEG-4 H.264 or AVC compression to balance quality against file size and is commonly associated with transferring DVD audio and video to hard disks. 'DivX Certified' DVD players can play DivX encoded movies.

DLNA

Digital Living Network Alliance aims to deliver an interoperability framework of design guidelines based on open industry standards to complete cross-industry digital convergence. The resulting 'digital home' should then be a network of consumer electronic, mobile and PC devices that transparently co-operate to deliver simple, seamless interoperability that enhances and enriches users' experience.

See also: HANA
Website: www.dlna.org

DLP™

(Texas Instruments Inc.) Digital Light Processing is the projection and display technology which uses digital micromirror devices (DMD) as the light modulator. It is a collection of electronic and optical subsystems which enable picture information to be decoded and projected as high-resolution digital color images. DLP technology enables the making of very compact, high brightness projectors. Over one million systems have been sold to the consumer market and DLP is also a major supplier to the cinema market.

See also: DLP Cinema, DMD
Website: www.dlp.com

DLP Cinema™

(Texas Instruments Inc.) DLP Cinema is a version of DLP technology that has been developed for digital electronic movie presentation. It contains extended color management and control and enhanced contrast performance. DLP Cinema is a major supplier of the digital cinema market with thousands of DLP Cinema technology-based projectors installed in commercial cinemas around the world. As the technology allows for fast frame rates of more than double the 24 f/s of normal cinema, it can be used to project stereo movies where left and right eye frames are sequenced through one projector – helping to make '3D' movies look good and easy to show.

See also: DLP, DMD
Website: www.dlp.com

DMB

Digital Multimedia Broadcasting. Developed and first adopted in South Korea (2005), DMB is a digital transmission system for television, radio and datacasting to mobile devices/ phone and can operate over satellite (S-DMB) or terrestrially (T-DMB). DMB is based on the Eureka 147 Digital Audio Broadcasting (DAB) standard, and has similarities with DVB-H, a competing mobile TV standard.

T-DMB (ETSI standard TS 102 427 and TS 102 428) uses MPEG-4 H.264 for video and HE-AAC V2 for the audio, together encapsulated in an MPEG-2 transport stream (TS). The encoded TS is broadcast on DAB in data stream mode. Application devices include mobile phones, portable TV, and PDAs as well as data/radio for cars.

See also: DVB-H, MediaFLO

DMD™

(Texas Instruments Inc.) Digital Micromirror Device. A silicon integrated circuit used to modulate light in a wide variety of applications. The most common use is in electronic projection systems where one or more devices are used to create high quality color images. The device is a memory circuit whose elements are arranged in a display format array matrix. Each element contains a square aluminum mirror which can tilt about its diagonal axis. The content of the memory cell causes the mirror to move from one tilt position to the other. By changing the memory data, the mirror can be switched very rapidly to create pulses of light whose duration causes the pixel to appear at a particular brightness – so producing the display of gray scales. DMDs are produced at different sizes according to the resolution required. The smallest contains over 500,000 mirrors. Devices with 1280 x 1024 (SXGA) and 2K (2080 x 1080) are widely used in digital cinema applications.

See also: DLP, DLP Cinema
Website: www.dlp.com

DNxHD

Avid's 'mastering-quality' HD codec with intra-frame compression designed for multi-generation compositing with reduced storage and bandwidth requirements. It has four levels to match quality requirements and manageable data volumes. 145 or 220 Mb/s 8-bit and 220 Mb/s 10-bit all at 4:2:2. There is also a 36 Mb/s version for HD offline. This offers HD post at SD data rates, or less, meaning that infrastructure and storage requirements can be as for uncompressed SD. DNxHD is currently undergoing standardization by SMPTE and may be designated VC-3.

Website: www.avid.com/dnxhd

Dolby

Dolby Digital (DD/AC-3) is a digital audio compression system that uses auditory masking for compression. It works with from 1 to 5.1 channels of audio and can carry Dolby Surround coded two-channel material. It applies audio masking over all channels and dynamically allocates bandwidth from a 'common pool'. Dolby Digital is a constant bit rate system supporting from 64 kb/s to 640 kb/s rates; typically 64 kb/s mono, 192 kb/s two-channel, 320 kb/s 35 mm Cinema 5.1, 384 kb/s Laserdisc/DVD 5.1 and DVD 448 kb/s 5.1.

DVD players and ATSC receivers with Dolby Digital capability can provide a backward-compatible mix-down by extracting the five main channels and coding them into analog Dolby Surround for Pro Logic playback.

Dolby Digital Plus offers more, better quality, channels and supports data rates up to 6 Mb/s. is backwards compatible with Dolby Digital players and is offered as 7.1 channels on HD DVD and Blu-ray with data rates up to 3 and 1.7 Mb/s respectively.

Dolby E is an audio compression scheme which can encode/decode up to eight channels plus metadata – typically 5.1 mix (six channels) and Rt/Lt (Right Total/Left Total surround) or stereo two-channel mix, etc – onto two AES/EBU bitstreams at 1.92 Mb/s (20-bit audio at 48 kHz). Thus video recorders, typically with four channels, can support the greater channel requirements of DVD and some DTV systems (e.g. ATSC). With audio frames matching video frames, Dolby E is a professional distribution coding system for broadcast and post production which maintains quality up to 10 code/recode cycles.

Dolby E is widely used in HD production to carry 5.1 sound. As it is locked to video frames it has to be decoded and re-coded to work with a frame-rate conversion process.

Dolby Surround (a.k.a. Dolby Stereo, Dolby 4:2:4 Matrix) offers analog coding of four audio channels – Left, Center, Right, Surround (LCRS), into two channels referred to as Right Total and Left Total (Rt, Lt). On playback, a Dolby Surround Pro Logic decoder converts the two channels to LCRS and, optionally, a sub-woofer channel. The Pro Logic circuits steer the audio and increase channel separation. The Dolby Surround system, originally developed for the cinema, is a method of getting more audio channels but suffers from poor channel separation, a mono limited bandwidth surround channel and other limitations. A Dolby Surround track can be carried by analog audio or linear PCM, Dolby Digital and MPEG compression systems.

Dolby TrueHD is a lossless compression system designed for high-definition disk-based media and claims to be bit-for-bit identical to the studio master. Running up to 18 Mb/s up to eight 24-bit/96 kHz channels are supported on HD DVD and Blu-ray Disc standards, and is expected to feature in future A/V receivers and downloadable media. It can connect over HDMI.

See also: Auditory masking, ATSC, Discrete 5.1
Website: www.dolby.com

Dominance

Field dominance defines whether a field type 1 or type 2 represents the start of a new interlaced TV frame. Usually it is field 1 but there is no fixed rule. Dominance may go unnoticed until flash fields occur at edits made on existing cuts. Replay dominance set the opposite way to the recording can cause a juddery image display. Much equipment, including Quantel's, allows the selection of field dominance and can handle either.

Down conversion

Down conversion is down-resing and/or changing vertical refresh rates (frame or field rates). For instance, moving from 1080/60I to 576/50I is a down-conversion.

See also: Cross conversion, Standards conversion, Up-res, Versioning

D

Down-res

Decreasing the size of video images to fit another format. Typically this reduces an HD format to an SD format and, as the input images represent over-sampled versions of output, the final quality should be excellent – better than an SD-shot original. Moving from 1080/60I to 480/60I is down-resing. Technically the process involves: spatial interpolation to reduce size while retaining quality, color correction to compensate for the difference in HD and SD color standards and possibly re-framing to fit 16:9 HD onto 4:3 SD. Note that down-res does not include any change of frame rate.

See also: Down conversion, Format conversion, Standards conversion, Up-res, Versioning

DPX

SMPTE file format for digital film images (extension .dpx) – ANSI/SMPTE 268M-1994. This uses the same raster formats as Cineon and only differs in its file header.

See Cineon file
Website: www.cineon.com/ff_draft.php#tv

DRAM

(1) see RAM
(2) Informal measure of Scotch Whisky

Drop-frame timecode

Alteration of timecode to match the 1000/1001 speed offset of NTSC transmissions and many newer HD video formats used in 'NTSC' countries – including the USA, Canada and Japan. 525-line NTSC at a nominal 30 f/s actually runs at 29.97 f/s and 1080-line HD uses the same frame rate. Even the 24 f/s of film gets modified to 23.97 when applied to TV in 'NTSC' countries. With timecode locked to the video, it needs to make up 1 in 1001 frames. It does this by counting two extra frames every minute while the video remains continuous. So 10:35:59:29 advances to 10:36:00:02. In addition, at every ten-minute point the jump is not done. This brings the timecode time almost exactly into step with the video.

Timecode that does not use drop-frame is then called non drop-frame time-code. Confusion arises when the wrong one is used!

See also: 1000/1001
Website: www.dropframetimecode.org

DSL

Digital Subscriber Line. A general term for a number of techniques for delivering data over the telephone local loop (between exchange and user) – the copper wires that make up the so called 'last mile'. Referred to generically as xDSL these offer much greater data speeds than modems on analog lines – up to 32 Mb/s upstream to the computer and 1 Mb/s or more downstream.

See also: ADSL

DSLAM

Digital Subscriber Line Access Multiplexer – usually located at the local telephone exchange, it connects multiple customer DSL lines to a high-speed ATM internet backbone line. It is the device that communicates with our ADSL (and SDSL) modems, creating a network similar to a LAN but without Ethernet distance restrictions, to provide an Internet connection for subscribers.

DSS

Digital Satellite Service. One of the terms used to describe DTV services distributed via satellite.

DTF and DTF-2

Digital Tape Format for storing data on half-inch cassettes at high data density on the tape and offering fast read and write speeds. Generally it is used for long-term file-based storage and the modern DTF-2 can store 518 GB (uncompressed) per cassette with a sustained data rate of 40 MB/s. In television/digital film applications DTF is often used as the archive in a facility with networked workstations.

See also: LTO, SAIT-2

DSM

See DCI

DTT

Digital Terrestrial Television – used in Europe to describe the broadcast of digital television services from traditional masts using terrestrial frequencies.

See also: ATSC, DVB, ISDB, T-DMB, DMB-T/H

For general information on worldwide digital transmission standards see

Website: www.dvb.org/about_dvb/dvb_worldwide

Dual link

The bandwidth of SDI and HD-SDI links allow the transport of uncompressed 4:2:2 sampled video and embedded digital audio. Dual links are often used to carry larger requirements – such as video with key (4:2:2:4), RGB (4:4:4) and RGB with key (4:4:4:4). Dual link for SD is defined in ITU-R/BT.799-2 and RP 175-1997. Dual link at HD is used for stereo3D and 50/60 P.

A dual link is arranged to allow some meaningful monitoring of each of the two links with standard equipment. So RGB is sent with Link A carrying full bandwidth G, half R and B (4:2:2). Link B is just half bandwidth R and B (0:2:2). RGB + Key is sent as (4:2:2) and (4:2:2).

See also: 0:2:2, 4:2:2, HD-SDI, HSDL, SDI, Y Cr Cb
Website: www.itu.ch

Duplex

(Full duplex) refers to communications that are simultaneously two-way (send and receive) – like the telephone. Those referred to as half-duplex switch between send and receive.

DV

This digital VCR format was formed jointly as a co-operation between Hitachi, JVC, Sony, Matsushita, Mitsubishi, Philips, Sanyo, Sharp, Thomson and Toshiba. It uses 6.35 mm (quarter-inch) wide tape in a range of products to record 525/60 or 625/50 video for the consumer (DV) and professional markets (Panasonic's DVCPRO and Sony's DVCAM).

All recorders use digital intra-field DCT-based 'DV' compression (about 5:1) to record 8-bit component digital video based on 13.5 MHz luminance sampling. The consumer versions and DVCAM sample video at 4:1:1 (525/60) or 4:2:0 (625/50) video and provide two 16-bit/48 or 44.1 kHz, or four 12-bit/32 kHz audio channels onto a 4-hour 30-minute standard cassette (125 x 78 x 14.6 mm) or smaller 1-hour 'mini' cassette (66 x 48 x 12.2 mm). The data rate is 25 Mb/s. The professional DVCPRO models make use of DV's hierarchical design, being x2 and x4 versions of the basic 25 Mb/s version.

DVCAM is Sony's professional variant of DV which records 15-micron tracks on a metal evaporated (ME) tape. As stated, video sampling is 4:2:0 for 625/50 (PAL) and 4:1:1 for 525/60 (NTSC). Audio is four 12-bit, 32 kHz channels, or two 16-bit 48 kHz channels.

DVCPRO is Panasonic's development of native DV which records 18-micron tracks onto metal particle tape. It uses native DV compression at 5:1 from a 4:1:1, 8-bit sampled source. There are 12 tracks per frame for 625/50 and 10 tracks per frame for 525/60, tape speed is 33.8 mm/s and the data rate 25 Mb/s. It includes two 16-bit digital audio channels sampled at 48 kHz and an analog cue track. Both linear (LTC) and Vertical Interval Timecode (VITC) are supported.

DVCPRO 50 is a x2 variant of DVCPRO. With a tape speed of 67.7 mm/s, a data rate of 50 Mb/s and using 3.3:1 video compression, it is aimed at the studio/higher quality end of the market. Sampling is 4:2:2 to give enhanced chroma resolution, useful in post production processes (e.g. chroma keying). Four 16-bit audio tracks are provided.

DVCPRO HD is a series of HD VTRs that are x2 variants of DVCPRO 50: tape speed 135.4 mm/s and a total data rate of 100 Mb/s. Sampling is 4:2:2. There are eight 16-bit, 48 kHz audio tracks. Formats supported include 1080I and 720P. This tape format has been assigned as D12. Later versions are using AVC-Intra Compression.

DVCPRO P2 is a DVCPRO recording system. It records the DV data in MXF format onto P2 cards which are PC plug-in cards with each carrying four SD (Secure Data) memory chips to combine capacity and aggregate transfer speeds – currently up to 640 Mb/s, many times realtime. The original P2 card offered 2 GB but the capacity keeps doubling so that now 32 GB cards are available. These are able to hold 128 minutes of DVCPRO, 64 minutes of DVCPRO 50 and 32 minutes of DVCPRO HD (1080/60I).

There is a roadmap of larger P2 cards to be introduced as higher capacity SD memory cards are launched. 64GB is to be delivered in the third quarter of 2008, and 128 GB (576 minutes DVCPRO) could be expected within a year. Up to five P2 cards can be plugged into some cameras at one time and are hot-swappable to transfer the recoded material for direct use in an edit system. Such workflows, with fast instant random access to the footage, can offer very fast turnarounds that are useful for news.

The P2 memory replaces electro-mechanical systems such as video tape or disks. It is rugged: resistant to impact, vibration, shock, dust and environmental extremes including sudden temperature changes, apparently withstands impact up to 1,500G and vibration up to 15G and operates in -20 to 60°C.

See also: AVC-Intra, ING
Website: http://panasonic-broadcast.com

DVB

Digital Video Broadcasting, the group, with over 200 members in 25 countries, which developed the preferred scheme for digital broadcasting in Europe. The DVB Group has put together a wide portfolio of broadcast standards; the major ones include a satellite system, DVB-S, and now the more efficient DVB-S2, a matching cable system, DVB-C (and now DVB-C2), and a digital terrestrial system, DVB-T. DVB-H is a newer broadcast standard designed for terrestrial operation with handheld devices where power must be conserved.

A mobile-by-satellite standard, DVB-SH, has been agreed and awaits standardization by ETSI. It can deliver IP-based media content and data to handheld terminals – phones and PDAs and operates below 3 GHz, typically in the S-band. Terrestrial gap fillers can provide any missing coverage where there is no line-of-sight path to the satellite.

DVB-S (1995) is the original DVB forward error coding and modulation standard for satellite television. DVB-S is used for both broadcast network feeds and for direct broadcast satellite services. DVB-S2 (2003) will probably be used for all future new European digital satellite multiplexes, and satellite receivers will be equipped to decode both DVB-S and DVB-S2. Currently its main use is to distribute HDTV. DVB-S2 is based on DVS-S adding two key features: allowing changing encoding parameters in realtime (VCM, Variable Coding and Modulation) and ACM (Adaptive Coding and Modulation) to optimize the transmission parameters for various users for a claimed net performance gain 30 percent.

DVB-T is a transmission scheme for digital terrestrial television (DTT). Its specification was approved by ETSI in February 1997 and DVB-T services started in the UK in autumn 1998. As with the other DVB standards, MPEG-2 sound and vision coding are used. It uses Coded Orthogonal Frequency Division Multiplexing (COFDM), which enables it to operate effectively in very strong multipath environments. This means DVB-T can operate an overlapping network of transmitting stations with the same frequency. In the areas of overlap, the weaker of the two received signals is rejected. Where transmitters carry the same programming the overlapping signals provide an area of more reliable reception, known as a signal-frequency network.

The DVB digital TV standard is predominant around the world. Notable exceptions are ATSC in the USA, ISDB in Japan, DMB-T/H (Digital Multimedia Broadcast-Terrestrial/Handheld) in China, and T-DMB in South Korea.

With the original DVB-T standard 10 years old the DVB TM-T2 technical group is working on technically more advanced DTT standards focusing on modulation, channel encryption and signal layout. The resulting DVB-T2 is predicted to offer a 30% increase in payload capacity over DVB-T under similar reception circumstances.

DVB over IP refers to delivery of digital television services (DVB) to homes over broadband IP networks. This could be supplied via cable or, possibly over copper telephone lines using high-speed DSL and the supplier could then achieve the 'triple play' – bundling voice (over-IP) telephone as well as Internet with the television service. This has great potential for interactive television as it includes a built-in fast return link to the service provider.

See also: COFDM, IP, IP over DVB
Website: www.dvb.org

DVCAM
See: DV

DVCPRO
See: DV

DVD
Digital Versatile Disk – a high-density development of the compact disk. It is the same size as a CD, 12 cm diameter, but stores upwards of 4.38 GB of actual data (seven times CD capacity) on a single-sided, single-layer disk. DVDs can also be double-sided or dual-layer – storing even more data.

The capacities commonly available are:

DVD-5	Single-side, single-layer	4.38 GB
DVD-9	Single-side, dual-layer	7.95 GB
DVD-10	Double-sided, single-layer	8.75 GB
DVD-18	Double-sided, dual-layer	15.9 GB

DVD-5 and DVD-9 are widely used. However the double-sided disks are quite rare, partly because they are more difficult to make and they cannot carry a label.

There are various types of DVD including:

DVD-R – recordable DVDs with a data capacity of 4.38 GB are popular and low priced.

DVD+R – dual layer recordable DVDs with a total capacity of two DVD-Rs.

DVD-RAM – re-recordable DVD, re-use up to around 100,000 times. Capacity of 4.38 GB (single-sided). Some new camcorders use these – they offer instant access to shot material and record loop features – useful when waiting to record an event, like a goal, to happen. At home it provides a removable media alternative to VHS. A particular feature is that it can record and replay at the same time.

DVD-Video – combines the DVD with MPEG-2 video compression, with multichannel audio, subtitles and copy protection capability.

D

To maximize quality and playing time DVD-Video uses variable bit rate (VBR) MPEG-2 coding where the bit rate varies with the demands of the material. Typically a 525/60 TV format, 24 f/s movie would use an average bit rate of 3.5 Mb/s, but for sections with a great deal of movement it could peak at 8 or 9 Mb/s. Only 24 f/s are coded onto the disk, the 3:2 pull-down conversion to 30 f/s taking place in the player. This allows a 120-minute 24 f/s movie to fit on a DVD-5. To store video (not film) with 50 or 60 discrete fields per second, the bit rate tends to average around 6 or 7 Mb/s, but again depends on the running time, original material and desired picture quality.

Multi-channel audio DVD-Video supports PCM, MPEG and Dolby Digital audio, for anything from mono, stereo, Dolby Surround to 5.1 channels. Digital Theatre Sound (DTS) and Sony Dynamic Digital Sound (SDDS) are options. Up to eight separate audio streams can be supported, allowing multiple languages, audio description, director's commentary, etc. For example, a release may have 5.1 Dolby Digital English, two-channel Dolby Digital Spanish with Dolby Surround, and mono French.

Region coding Disks can be region-coded and so only play in a particular region (as defined in the player), a set of regions or be 'code-free'.

The region numbers are:

1. Canada, US, US Territories
2. Japan, Europe, South Africa, Middle East (including Egypt)
3. Southeast Asia, East Asia (including Hong Kong)
4. Australia, New Zealand, Pacific Islands, Central America, South America, Caribbean
5. Former Soviet Union, Indian Subcontinent, Africa (also North Korea, Mongolia)
6. China

See also: HD DVD, Blu-ray Disc, Dolby Digital, Dolby Surround, MPEG-2, MPEG-4

DVE

Digital Video Effects (systems). These have been supplied as separate machines but increasingly are being included as an integral part of systems. The list of effects varies but will always include picture manipulations such as zoom and position and may go on to rotations, 3D perspective, page turns, picture bending and curls, blurs, etc. Picture quality and control also vary widely depending on the processing techniques used.

See also: Axis, Global

DVTR

DVTR – Digital Video Tape Recorder. Sony showed the first DVTR for commercial use in 1986, working to the ITU-R BT.601 component digital video standard and the associated D1 standard for DVTRs. It used 19 mm cassettes recording 34, 78 or (using thinner tape) 94 minutes. Today all new VTR formats are digital and are available for HD as well as SD and from professional to consumer standards. Due to its relatively high cost, D1 is rarely used today. Other formats D2 and D3 that recorded digitized composite PAL and NTSC are becoming extinct. All modern tape recorders are digital and use some form of compressed component video – the exception being Thomson's VooDoo Media Recorder (a.k.a. D6).

Provided there is no re-coding or transcoding, DVTRs do not suffer 'generation loss' due to re-recordings as tape noise, moiré, etc., and dropouts are mostly invisible due to sophisticated correction and concealment techniques. However tape is subject to wear and tear and the resulting errors and dropouts necessitate complex error concealment circuitry. In extreme cases multiple passes can introduce cumulative texturing or other artifacts.

Today, tape is generally widely used in acquisition and for distributing programs, but the post production is nearly all disk-based.

See also: Betacam SX, D5, D9, DV, DVCPRO, HDCAM

Dylan®

Media storage technology first developed by Quantel in 1993 to support SD editing and compositing systems. It has continually expanded and today provides features beyond those of generic video storage solutions including FrameMagic with multi-channel realtime access to any frame and large bandwidth for realtime operation up to multiple uncompressed 4K streams. It makes an excellent store for nonlinear systems (eQ, iQ, Pablo) and for servers (sQ server).

There is RAID-5 protection so that, should a disk drive fail, operation continues and no data is lost. Implemented in Quantel's generationQ systems it is resolution co-existent, holding any mix of formats including SD, HD and film, and color space independent storing RGB and Y,Cr,Cb, etc. It does not need de-fragmenting and the total storage capacity is therefore always available – regardless of fragmentation.

See also: Color space, FrameMagic, RAID, True random access

Dynamic range

For images – the measurement of the range of brightness in a scene expressed as a ratio or the Log_{10} of the ratio. Typically a lighting cameraman will try to keep a scene to less than 40:1 (Log = 1.6) to avoid loss of detail in the print. A 100:1 (Log = 2) contrast range in the scene is a typical maximum.

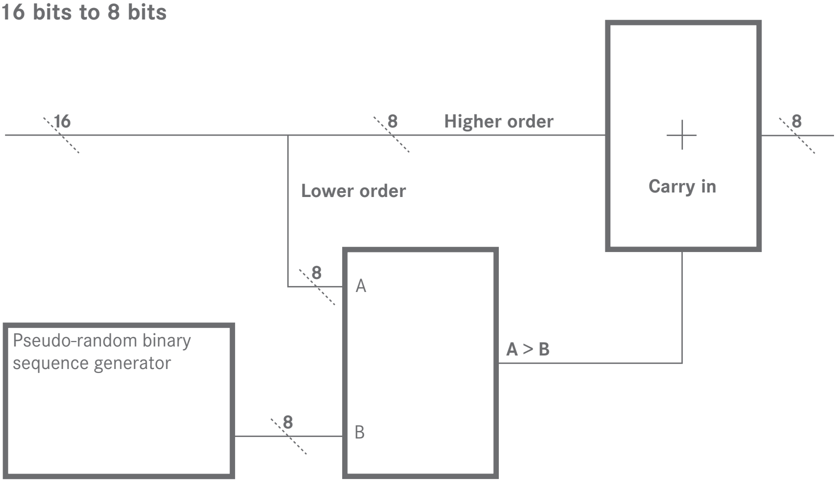
See also: Cineon file

Dynamic Rounding®

Dynamic Rounding is a mathematical technique devised by Quantel for truncating the word length of pixels to a specified number of bits. Rather than simply ignoring the lower bits, it uses their information to control, via a randomizer, the dither of the LSB of the truncated result. This effectively removes the artifacts, such as banding, that could otherwise be visible. Dynamic Rounding is non-cumulative on any number of passes and produces statistically correct results. Earlier attempts at a solution have involved increasing the number of bits, making the size of LSBs smaller but not removing the inherent problem.

Some form of limiting the number of bits is required as there are many instances in digital systems where a number, representing a pixel value, uses more bits than the system normally accommodates. For example, a nominally 12-bit system might have a problem handling a 24-bit word. This has to be rectified in a way that will keep as much information as possible and not cause noticeable defects – even after many processes. A common example is image processing which generally involves multiplying the pixel values of two images, as in digital mixing. Assuming the equipment is nominally 12-bit, the mixing produces a 24-bit result from two original 12-bit numbers. At some point this has to be truncated, or rounded, back to 12-bits either to fit within the structure of the equipment or to be accepted by external interfaces. Simply dropping the lower bits can result in unwanted visible artifacts especially when handling pure, noise-free, computer generated pictures.

16 bits to 8 bits



Dynamic Rounding is licensable from Quantel and is used in a growing number of digital products both from Quantel and other manufacturers.

See also: Digital mixing, LSB

EBU

European Broadcasting Union. An organization comprising European broadcasters which co-ordinates the production and technical interests of European broadcasting. It has within its structure a number of committees which make recommendations to ITU-R.

See also: Directory
Website: www.ebu.ch

E

ECC

Error Check and Correct. This system appends check data to a data packet in a communications channel or to a data block on a disk, which allows the receiving or reading system both to detect small errors in the data stream (caused by line noise or disk defects) and, provided they are not too long, to correct them.

See also: Checksum, CRC

EDL

Edit Decision List. A list of the decisions that describe a series of edits. EDLs can be produced during an off-line session and passed to the on-line suite to control the conforming of the final edit. In order to work across a range of equipment there are some widely adopted standards such as CMX 3400 and 3600. News journalists working with integrated news production systems, such as Quantel's generationQ news systems, can effectively create EDLs at their desktops.

EDLs have been frozen in time and not kept pace with the continued development of post production. They do not carry information on DVEs, color correction, layering, keying etc., or carry other data about ownership, rights, etc. The development of AAF has filled these gaps.

See also: AAF, Conform, OMFI

Effects (digital film)

Digital effects processes have replaced the traditional film optical effects, and provide a lot more toward the completion of the project. Initially this was a separate digital operation aside from the mainstream photochemical work, but now, with DI becoming popular, it works alongside the digital workflow.

Digital 'optical' film effects can retain their full image quality irrespective of the number of effects layers used, provided that the images remain uncompressed. The results can generally be seen immediately making the process interactive and able to quickly refine the result. All this can be seen in context with the rest of the movie, making for better continuity and less need of final grades.

E

Electronic program guides (EPG)

DTV allows broadcasters to transmit electronic program guides. For many, this service is considered essential to keep viewers up to date with, and enable them to navigate between, the increased number of channels DTV brings. The program guide database allows a receiver to build an on-screen grid of program information and contains control information to ease navigation.

Embedded audio

Audio that is carried within an SDI or HD-SDI data stream – so simplifying cabling and routing. The standard (ANSI/SMPTE 272M-1994) allows embedding up to four groups each of four mono audio channels.

48 kHz synchronous audio sampling is pretty well universal in TV but the standard also includes 44.1 and 32 kHz synchronous and asynchronous sampling. Synchronous means that the audio sampling clock is locked to the associated video (1920 samples per frame in 625/50, 8008 samples per five frames in 525/60). Up to 24-bit samples are allowed but mostly only up to 20 are currently used.

48 kHz sampling means an average of just over three samples per line, so three samples per channel are sent on most lines and four occasionally – the pattern is not specified in the standard. Four channels are packed into an Ancillary Data Packet and sent once per line (hence a total of 4 x 3 = 12 or 4 x 4 = 16 audio samples per packet per line).

See also: 1000/1001

Encryption

The process of coding data so that a specific code or key is required to restore the original data. In conditional access broadcasts this is used to make transmissions secure from unauthorized reception and is often found on satellite or cable systems. Today, the growth of digital services to homes is in danger of being held back because of the content owners' concern about piracy – digital copies being perfect clones of their valuable assets. Encryption and content security are vital to the growth of digital media markets.

ENG

Electronic Newsgathering. Term applied to a small portable outfit, with a broadcast quality TV camera, VTR and/or microwave link, usually used for news. The term was originated to distinguish between newsgathering on film and video tape (electronic). ENG refers to compatible studio or portable editing equipment.

See also: ING

Entry point
A point in a coded bit stream from which a complete picture can be decoded without first having to store data from earlier pictures. In the MPEG-2 frame sequence this can only be at an I-frame – the only frames encoded with no reference to others.

EPK
Electronic Press Kit is a film deliverable usually consisting of film excerpts, trailers and interviews produced to help publicize a film.

Error detection, concealment and correction
No means of digital recording is perfect. Both magnetic tape and disks suffer from a few marginal areas where recording and replay is difficult or even impossible. However the errors can be detected and some remedial action taken by concealment or correction. The former attempts to hide the problem by making it less noticeable whereas the latter actually corrects the error so that perfect data is output.

When the recorded data is an image, an error can simply be concealed by using data from previous or following TV lines, fields or frames. The result is not guaranteed to be identical to the original but the process is relatively simple and, as important, quick. If the stored information is from a database, a computer program or from special image processing, then 100% accuracy of data is essential. This can be ensured by recording data in a manner where any errors can be detected and the correct data calculated from other information recorded for this purpose. This is error correction.

A difference between computer systems and TV is that the latter is continuous and cannot wait for a late correction. Either the correct result must be ready in time or some other action taken – the show must go on – placing a very tight time constraint on any TV-rate error correction. In contrast, a computer can usually afford to wait a few milliseconds.

Digital VTRs monitor the error rate and provide warnings of excessive errors, which although not immediately visible, may build up during multiple tape passes.

Although error rates from disks are generally many times lower than those expected from digital videotape, they can still occur. To protect against this there is data redundancy and the replay of all data is checked. If an error is detected there is sufficient additional information stored to calculate and substitute the correct data. The total failure of a disk drive can be covered and the missing data re-generated and recorded onto a new replacement – making the system highly accurate and very secure.

See also: ECC, Dylan, EXOR, RAID

Essence
The material that television programs are made of. In other words, the video, audio and any other material such as graphics and captions that are added to make up the final result.

See also: AAF

E

Ethernet

Ethernet is a form of Local Area Network (LAN) widely used for interconnecting computers and standardized in IEEE 802.3, allowing a wide variety of manufacturers to produce compatible interfaces and extend capabilities – repeaters, bridges, etc. The data transmission rate is 10, 100 Mb/s up to 1 and 10 Gb/s, but overheads in packaging data and packet separation mean actual throughput is less than the 'wire speed' bit rate.

There are many connection methods for Ethernet varying from copper to fiber optic. Currently the three most common are:

10 Base-T The standard for 4-wire twisted pair cable using RJ connectors. This gives extremely low cost-per-node network capabilities.

100 Base-T (a.k.a. Fast Ethernet) 100 Mb/s 4-wire twisted pair cable using RJ connectors is now becoming very popular. Similar technology to 10 Base-T but uses Cat. 5 cable.

Gigabit Ethernet (GigE) Development of existing Ethernet technology to support 1,000 Mb/s. This is specified for both fiber and copper Cat. 5e.

10 Gigabit Ethernet (10GigE) only functions over copper for short distances – 15 meters using twinax cable. Using augmented cat. 6 (Cat 6A) cable it may travel twice that distance. For longer range optical fiber is the only answer. This only operates in full-duplex mode – so collision detection protocols are unnecessary. But the packet format and other current Ethernet capabilities are easily transferable to 10GigE.

100 Gigabit Ethernet (100GigE) continues the x10 steps of Ethernet data speed evolution. Destined to travel over optical fiber, it is at the development stage but will doubtless emerge into the commercial world sometime soon.

See also: Hub, CSMA/CD, Switch
Websites: www.ethernetalliance.org
www.ethermanage.com/ethernet/ethernet.html

ETSI

The European Telecommunications Standards Institute. Its mission is to produce lasting telecommunications standards for Europe and beyond. ETSI has 655 members from 59 countries inside and outside Europe, and represents administrations, network operators, manufacturers, service providers, research bodies and users.

See: Appendix
Website: www.etsi.org

ETSI compression

A compression technique, based on DCT. Unlike MPEG, which is asymmetrical having complex coders and simpler decoders and is designed for broadcast, this is symmetrical with the same processing power at the coder and decoder. It is designed for applications where there are only a few recipients, such as contribution links and feeds to cable head ends. ETSI compression is intra-frame, simpler than MPEG and imposes less delay in the signal path, typically 120 milliseconds against around a second, enabling interviews to be conducted over satellite links without unwarranted delays. Data rate is 34 Mb/s.

eVTR

A colloquial term for a Sony IMX VTR with an Ethernet connection.

See also: D10

EXOR

The mathematical operation of EXclusive OR logic gate on a number of data bits. For example the EXOR of two bits is 1, only if one of them is 1. The EXOR is widely used in data recovery (see RAID). If the EXOR of a number of blocks of data is stored, when one of those blocks is lost, its contents can be deduced by EXORing the undamaged blocks with the stored EXOR.

See also: Error detection

Exposure

Exposure refers to the amount of light that falls on a film or light sensor. In a camera this is controlled by both time with the shutter, and the effective lens aperture, referred to as the F-number or T number.

See also: Density, Stop

FAN

File Area Networks are a shared storage concept that stores shared files in multiple locations. However the user is not aware of where the files are located; they are simply accessed as if they were local or single site storage. The IT industry is actively pursuing this concept in order to provide organizations with strategically central data sources that are geographically agnostic, which can lead to considerable resource savings.

FANs also have potentially broad applications in post production and broadcast. It is not impossible to imagine a post house with a ‘front door’ in the city where clients can come and watch their job progress, driven by a creative at in his country retreat – perhaps with the storage itself in a third location. Broadcasters with multiple sites (perhaps local stations or subsidiaries) are also looking at FANs with great interest.

Website: http://en.wikipedia.org/wiki/File_Area_Network

F

Fibre Channel (FC)
An integrated set of standards developed by ANSI designed to improve data speeds between workstations, supercomputers, storage devices and displays while providing a single standard for networking storage and data transfer. It can be used point-to-point, switched or in an arbitrated loop (FC-AL) connecting up to 126 devices.

Planned to run on a fiber-optic or twisted-pair cable at an initial data rate of 1Gb/s, 2, 4 and now 8 Gb/s (8GFC) have become available. There is also a road map to 16 Gb/s. These are nominal wire speeds but 8b/10b encoding is used to improve transmission characteristics, provide more accuracy and better error handling. With every 8-bit data byte for transmission converted into a 10-bit Transmission Character, the useful data rate is reduced by 20 percent.

Because of its close association with disk drives, its TV application is mostly, but not always, in the creation of storage networking. It can interface with the SCSI disk interface, which is key to its operation in storage networking such as SAN.

See also: SAN
Website: www.fibrechannel.org

File-based (media)
'File-based' generally refers to storing media in files rather than as continuous streams – like video tape. The term is more widely used to describe IT-based environments for handling and processing digital media. Many see the future of media production as being file-based.

File transfer
A discontinuous transfer process which treats each transferred item as a single block, neither divisible into smaller, independent elements nor part of a larger whole. As the transfer process has a recognizable beginning and end (unlike streaming) it is possible for the complete transfer to be checked and any errors corrected. This is not possible with a streaming process.

File transfer requires material to be complete and clearly identifiable. When handling time-based material, such as video and audio this the complete file has to be available before transfer can start. If the whole clip is a single file, this cannot be transferred until all the material is complete. However, if the clip is sub-divided, for example into frames, the transfer can start immediately after the first frame is completed. This becomes important in time sensitive applications such the live editing of highlights while the event is still taking place.

See also: Streaming

Film formats
Unlike pre-HD television, which had only two image formats, 525/60I and 625/50I, 35 mm film has many. Of these the most common are Full Frame, which occupies the largest possible area of the film, Academy and Cinemascope. The scanning for these is defined in the DPX file specification as follows:

Scanning resolution	Full frame	Academy	Cinemascope
4K	4,096 x 3,112	3,656 x 2,664	3,656 x 3,112
2K	2,048 x 1,556	1,828 x 1,332	1,828 x 1,556
1K	1,024 x 778	914 x 666	914 x 778
Aspect Ratio	1.316	1.372	1.175

These scan sizes generally represent the valid image size within the total frame size indicated by full frame. It is generally considered that all scanning is done at full frame size as this avoids the complexity of adjusting the scanner optics or raster size with risks associated with repeatability and stability. Although these digital image sizes came about as formats for scanning film, new digital cinematography cameras are also using them, exactly or nearly. In the file-based world of DI the exact size does not matter, as long as it's managed correctly and, most importantly, able to produce high quality output for release prints and digital cinema – where the DCI specifies exact sizes.

2K has 3.19 Mpixels and a 1.316:1 aspect ratio. It is used for digitizing full frame 35mm motion picture film sampled in 4:4:4 RGB color space – making each image 12 MB. Sampling is usually at 10-bit resolution and may be linear or log, depending on the application, and is progressively scanned.

Note that the sampling includes 20 lines of black between frames because of the use of a full frame camera aperture. Thus the actual 'active' picture area is 2048 x 1536, has a 4:3 aspect ratio and is exactly QXGA computer resolution. Removing the aperture creates an 'open gate' format which may have no black bar between frames – then all 1556 lines carry picture information.

4K is a x4-area version of 2K, with 12.76 Mpixels. Once again the format includes 'black' lines – 40 this time, so the actual full frame image is 4096 x 3092. Historically many aspects of handling 4K have been problematical – not least due to the large data rate (over 1.1 GB/s) and the amount of data produced – about 4 TB/h. However modern technologies applied all the way from scene to screen have now made 4K far more readily accessible. For some time, 4K has been the format of choice for some complex effects shots where it was felt these needed extra quality (over 2K) to still look good after all the necessary processes are completed, specially where the finished shots are inter-cut with the original negative. Now it is increasingly being used for whole movies.

DCI 4K and 2K sizes for exhibition in digital cinemas are not the same as the DPX values above. They are 2K (2048 x 1080), 4K (4096 x 2160), quite close to the 1.85:1 aspect ratio of Cinemascope.

In addition, different camera apertures can be used to shoot at different aspect ratios. All these (below) are 'four perf' (a measure of the length of film used) and so all consume the same amount of stock per frame. Note that scanners (and telecines) typically change scan size to maintain full 2K or 4K images regardless of aspect ratio. It is no longer normal for work to be scanned at a fixed full frame size.

Format	Width mm	Height mm
Full Frame	24.92	18.67
Academy	21.95	16.00
Cinemascope	21.95	18.60
1.66:1	21.95	13.22
1.75:1	21.95	12.54
1.85:1	21.95	11.86

There are many more 35 mm formats in use.

For lower-budget movies Super 16 can be used. Though if targeting an HD production, there is an ongoing discussion as to whether S16 is acceptable.

See also: MTF

Film recorder

Equipment which inputs digital images and outputs exposed negative film. In this area, CRT, laser-based and D-ILA LCOS imaging device technology recorders expose high-resolution images onto film. Here there is some emphasis on speed as well as image quality. Currently the 2K (4K) output times are, for laser-based models 1.7s (3.8), CRT-based recorders 1s (3.5) and the D-ILA LCOS imager exposes 3 f/s (4K not known).

Time is important as, if the speed is fast, the cost of output could fall and encourage making multiple recordings to internegatives, from which all the release prints can be made directly for best quality and lower costs.

Websites: www.arri.com
www.celco.com
www.imagica.com

Film scanner

A general term for a device that creates a digital representation of film for direct use in digital television or for digital intermediate work. For television, film scanners are now replacing traditional telecines. For digital film, they should have sufficient resolution to capture the full detail of the film so that, when transferred back to film, the film-digital-film chain can appear as an essentially lossless process. For this, film scanners are able to operate at greater than HD resolutions (1920 x 1080). Initially 2K was the most commonly used format but 4K is gaining in popularity depending on budget and the suitable technology being available. The output is data files rather than the digital video that would be expected from a traditional telecine.

The dynamic resolution needs to fit with the on-going process. If the digital material is treated as a 'digital camera negative' for a digital intermediate process, then it must retain as much of the negative's latitude as possible. In this case the material is transferred with a best light pass and the linear electronic light sensors, often CCDs, have to sample to at least 13 bits of accuracy (describing 8192 possible levels). Using a LUT, this can be converted into 10-bit log data which holds as much of the useful information but does not 'waste' data by assigning too many levels to dark areas of pictures.

Note that this is different from using a telecine to transfer film to video. Here, normal practice is to grade the film as the transfer takes place so additional latitude is not required in the digital state. Here 10 or 8 bits linear coding is sufficient.

FireWire

See IEEE 1394

Flash Memory

Non-volatile solid-state memory that offers fast read times, but not as fast as DRAM, and can withstand considerable shock (G-force). Hence its popularity for as storage on battery-powered devices. Also when packaged in a memory card or a 'pen drive' case, it is enormously durable, withstanding intense pressure, extremes of temperature and even water immersion.

There are many technologies applied to make flash memories and development continues at a frantic pace: 2005 – 1GB, 2GB; 2006 – 4GB, 64GB. Transfer rates are from 2-12 MB/s and are often quoted as multiples of the standard CD rate of 150kB/s (= x1). There is an emerging potential for flash memory to replace computer hard drives – with solid-state drives (SSD). Current offerings are up to 128 GB with read x2 and write x60 times faster than disks, low power consumption and high robustness this has many advantages. Cost prohibits a large-scale defection from the traditional rotating mass PC storage device – at the moment.

F

Flash – double and triple

Double flash is commonly used in film projectors so that each of the 24 f/s is shown twice – a total of 48 f/s. This means the movie presentation has less flicker. Triple flash is better still with a frames rate of 72 f/s.

When presenting 3D cinema, the left and right eyes want motion and the parallax to appear at the same time but the sequential frame presentation of 3D, often using a single projector, naturally offsets motion timing. Double, or better triple, flash improves the motion portrayal. Here total frame rates are double that of 2D, so:

single flash is 48 f/s
L1, R1, L2, R2, etc.

double flash is 96 f/s
L1, R1, L1, R1, L2, R2, L2, R2 etc

triple flash is 144 f/s
L1, R1, L1, R1, L1, R1, L2, R2, L2, R2, L2, R2 etc.

Note that the cine player offers only 24 left and right frames/s. It is the job of the projector to present each frame two or three times. Of course, the projector has to be capable of clearly showing frames at that rate.

Floating edges or Floating window (Stereoscopic)

See: Breaking the frame (Stereoscopic)

Flop

A floating point calculation per second. Flops are a measure of processing power and today this runs into Gigaflops. For example, the powerful Cell processor used in PlayStation 3 is rated at somewhere between 218 and 250 Gigaflops.

Format conversion

Changing the format of television or other moving media images without changing the vertical (frame or field) refresh rate. So, starting with 1920 x 1080/50I and converting to 720 x 576/50I is a format conversion. This only alters the format spatially, changing the vertical and horizontal size which technically is a relatively straightforward task. Note that this may include aspect ratio conversion (ARC) typically to account for 16:9 and 4:3 displays.

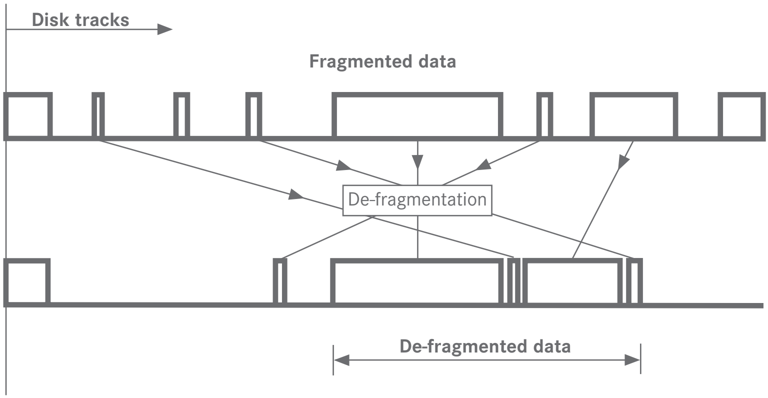
See also: ARC, Down-res, Standards conversion, Up-res

Format (television)

General term to define television pictures by the number of active pixels per line and number of active lines. For example, SD digital television in Europe has a format of 720 x 576 and 1920 x 1080 is an HD format.

See also: Standards (television)

Fragmentation
The scattering of data over a (disk) store caused by many recording and deletion operations. Generally this will eventually result in store access becoming slow – a situation that is not acceptable for video recording or replay. The slowing is caused by the increased time needed to access randomly distributed data or free space. With such stores de-fragmentation routines arrange the data (by copying from one part of the disk to another) so that it is quickly accessible in the required order for replay. Clearly any change in replay, be it a transmission running order or the revision of an edit, could cause further fragmentation.



Stores capable of true random access, such as Quantel's sQ server are able to play frames in any order at video rate, and never need de-fragmentation.

See also: Consolidation, FrameMagic

FrameMagic
Quantel term describing an advanced form of the management of video in a server. This covers much ground but basically offers the practical goals of guaranteeing realtime access to any frame for all video connections (simultaneous true random access) and avoiding the deletion of any material by one user that is partly or wholly used by another.

This is achieved by implementing a number of basic design criteria, including realtime random access to any frame, storing video material as a series of individual frames, rather than longer video files, as well as an on-board realtime database management system which, among other things, tracks who is using what material. FrameMagic is implemented in Quantel's sQ servers.

See also: Delta Editing

F

Frame-rate conversion

The process of changing the vertical rate of moving pictures. This has become far more important with the use of HD and its inclusion of many frame rates in the standards. For example 1080-line standards are defined for 23.98P, 24P, 25P, 29.97P, 30P, 50I, 50P, 59.96I, 59.96P and 60I and 60P Hz. Changing from one rate to another, even just I/P changes, requires considerable technology to produce high quality results. Further frequencies are used in other media markets, such as mobile and some web-based areas with more restricted bandwidth, where lower rates such as 15 f/s and others are found.

Framestore

The name, coined by Quantel, given to solid-state video storage, usually built with DRAMs. Technically it implies storage of one complete frame or picture, but the term is also used more generically to encompass the storage of a few lines to many frames. With large DRAM capacities available, framestores are increasingly used to enhance equipment performance for instant access to material.

See also: DRAM

Frequency

The number of oscillations of a signal over a given period of time (usually one second). For example, it defines the color subcarrier frequencies in analog television color coding systems, or clock rate frequencies in digital systems. Here are some commonly found frequencies in TV:

PAL subcarrier:	4.43 MHz
NTSC subcarrier:	3.58 MHz
ITU-R BT.601 luminance sampling rate:	13.5 MHz (SD)
ITU-R BT.601 chrominance sampling rate:	6.75 MHz (for 4:2:2 SD sampling)
ITU-R BT.709 luminance sampling rate:	74.25 MHz (HD)
ITU-R BT.709 chrominance sampling rate:	37.125 MHz (for 4:2:2 HD sampling)

Although not appearing in any prominent headline, 2.25 MHz is important as the lowest common multiple of both 525 and 625 line frequencies. Multiples of 2.25 MHz also make up many of the frequencies used for digital video sampling of SD and HD.

See also: 13.5 MHz

FTP

File Transfer Protocol. The high level Internet standard protocol for transferring files from one machine to another. FTP is usually implemented at the application level.

Full HD

Full HD is a term describing video at 1920 x 1080 resolution. Generally this appears as a logo on flat panel TV sets that have screens able to display all the pixels of the 1920 x 1080 images supplied from HD sources such as broadcast transmissions and HD DVD and Blu-ray Discs. The panels only use progressive scans so they are showing 50P and 59.94P frame rates. The logo will multiply and migrate to spread into consumer areas and appear on the latest consumer camcorders using the 1920 x 1080 image size.

Full motion video

A general term for moving images displayed from a desktop platform. Its quality varies and is undefined.

Gamma

Gamma has several meanings. In the video world a CRT television monitor's brightness is not linearly proportional to its driving voltage. In fact the light output increases rapidly with drive. The factor, gamma, of the CRT, is generally calculated to be 2.6. This is compensated for in TV cameras by a gamma of 0.45 giving an overall gamma of 0.45 x 2.6 = 1.17 – adding overall contrast to help compensate for domestic viewing conditions.

In film, gamma describes the average slope of the D/Log E curve over its most linear region. For negative stocks this is approximately 0.6, for intermediate stocks this is 1.0 and for print stocks 3.0. This gives a system gamma of 0.6 x 1 x 3 = 1.8. This overall boost in contrast is much reduced due to flare and auditorium lighting conditions.

With video now available on many varying types of devices there may be a need to re-visit the gamma settings as, for example, a digital film master is versioned for mobile phones, and home TV (where viewers have CRT, LED and plasma displays) as well as digital and film cinema. This can be done by applying suitable LUTs for each version.

See also: Internegative, Interpositive

Gamut

In image media this usually refers to the available range of colors – as in Color Gamut. This varies according to the color space used; YCrCb, RGB, X´Y´Z´ and CMYK all have different color gamuts.

See also: Illegal colors

Gateway

A device connecting two computer networks. For example, a gateway can connect a local area network (LAN) to a SAN. This way a PC connected on an Ethernet LAN may have access to files stored on the SAN even though the PC is not SAN aware.

Generation loss

The signal degradation caused by successive recordings. Freshly recorded material is first generation; one re-recording, or copy, makes the second generation, etc. This was of major concern in analog linear editing but much less so in a digital suite. Non-compressed component DVTRs should provide at least twenty tape generations before any artifacts become noticeable but the very best multi-generation results are possible with disk-based systems. These can re-record millions of times without causing dropouts or errors. Generations are effectively limitless... very useful if building multi-layer video effects.

Besides the limitations of recording, the action of processors such as decoders and coders will make a significant contribution to generation loss. The decode/recode cycles of NTSC and PAL are well known for their limitations but caution is needed for digital video compression (coding) systems, including MPEG and DV, as well as the color space conversions that typically occur between computers handling RGB and video equipment using Y,Cr,Cb.

See also: Concatenation, Error detection concealment and correction

Ghosting (Stereoscopic)

Artifacts typically caused by signal leakage (crosstalk) between the two 'eyes'. A secondary 'ghost' image can be seen. There are several possible causes that can introduce the problem during acquisition, post production and display. One reason can be high contrast levels between an object and its background.

Gigantism (Stereoscopic)

Confusing visual cues in a stereoscopic scene that can make an object appear to be the 'wrong' size, i.e. the impression of strangely enlarged size of objects. This is due to the choice of interocular distance relative to the focal length of the camera lenses, e.g. shooting with an interocular distance much less than that of adult human eyes can make a figure appear to be a giant.

See also: Miniaturization, Interocular

Gigabit Ethernet

See Ethernet

Global (control)

The top level of control in a multi-channel DVE system. A number of objects (channels) can be controlled at one time, for example to alter their opacity or to move them all together relative to a global axis – one which may be quite separate from the objects themselves. This way the viewing point of all the assembled objects can be changed. For example, a cube assembled from six channels could be moved in 3D space as a single action from a global control.

See also: Axis

G

Googol

The number 10^{100} (1 with 100 zeros after it).

GOP (Group Of Pictures)

See MPEG-2

GPI

General Purpose Interface. This is a simple form of control interface typically used for cueing equipment – usually by a contact closure. It is simple, can be frame accurate and therefore can easily be applied over a wide range of equipment.

GPU

Graphics processing unit. A chip or digital circuit designed specifically for processing graphics and generally providing the main processing power of a computer graphics card. Having much more graphics power and speed than central processor unit (CPU) chips, GPUs can take over many of complex 2D and 3D processing tasks from the CPU.

However GPUs are not as versatile as CPUs and some graphics tasks may still need to go through CPUs or other specific processors. GPUs are now found in a wide range of image processing equipment – such as picture color correctors and graders as well as the high-end television graphics equipment including that for live '3D' graphics and virtual sets.

G

Grading (a.k.a. color timing)

Grading is the process of adjusting the color of a clip to get the best out of the material or to match shots perhaps taken at different times or in different lighting conditions. In film, grading was traditionally done when going from internegative to print film by controlling the exposure of the film. In television it was traditionally done off the telecine for commercials or tape-to-tape for longform programs. Either way, both processes were by their nature linear.

The advent of non-linear grading systems (such as Quantel's Pablo) has once again changed the rules for color correction. While there is still a requirement for an initial technical scan for film-originated material, from this point on, grading can – and often does – happen at multiple stages in the post production process. It is now possible – and usually desirable – to color correct individual layers within composites (which may be shot under different lighting conditions) to ensure that the result is harmonious within itself, and non-linear working means that scene-to-scene comparisons and corrections can be made as the edit unfolds. This eases the final grading process when the finished work is reviewed interactively with the director/client.

Secondary color correction is aimed at controlling a particular color or a narrow range of colors – such as those on a car or product. Here typically the hue, gain and saturation can be changed. There are also several methods available for defining the object, area or 'window' of required color correction such as using wipe-pattern shapes, drawing an electronic mask by hand or a combination of automatic and by-hand methods. Some of the most sophisticated tools are provided by media workstations such as Quantel's eQ, iQ and Pablo.

See also: Film scanner, Grading, Telecine

Grain management

Controlling the amount of 'film' grain visible on a film or digital movie. Its appearance is considered by some to add a certain look to the production. Modern DI equipment can include grain management that can increase or decrease its visibility on film or digitally originated material. Aside from aesthetics, grain affects compression systems as they see it as extra movement and so can waste bandwidth by coding it – adding another reason for controlling the amount of grain according to the different coding requirements for, say, digital cinema and mobile reception.

Granularity

Term describing limits of accuracy or resolution. For example, in editing the granularity of uncompressed component video (601 or 709) is one frame; i.e. it can be cut on any frame. The granularity of long GOP MPEG-2 is about half a second – about 12 or 15 frames. In a digital imaging system the granularity of brightness is the minimum change per sample – corresponding to the effect of an LSB change.

GSN

Gigabyte System Network. Developed by SGI and others for the efficient movement of large quantities of data, it allows realtime transfers of larger-than-HD images on a network. GSN allows transfer speeds up to 800MB/s, has low latency, and is an ANSI standard compatible with HIPPI, Ethernet, and other standard networks, providing full-duplex data transmission over up to 200m.

Website: www.hnf.org

GUI

Graphical User Interface. A means of controlling or operating a system through the use of interactive graphics displayed on a screen. Examples in the computer world are the Apple Macintosh and Microsoft Windows, both designed for general-purpose use and usually operated with a mouse as the pointing device.

In 1981 Quantel introduced Paintbox with its on-screen menu system operated from a pressure sensitive pen and touch tablet. This purpose-built control has been further developed to cover a wide range of operations including DVEs, editing, VTR control, color grading and audio, and today is applied to the whole range of Quantel products. Besides its success in offering fast and effective control, the GUI also enables easy updates to accommodate new facilities.

H.264

See: MPEG-4

HANA

High-Definition Audio-Video Network Alliance, founded and supported by several media and electronics companies, aims to develop technology guidelines that will make it easier for consumers to enjoy high definition television across their home entertainment systems. The guidelines would allow the transfer of HD between TVs, computers and other devices without multiple connecting wires and remote controls.

See also: DLNA
Website: www.hanaalliance.org

H

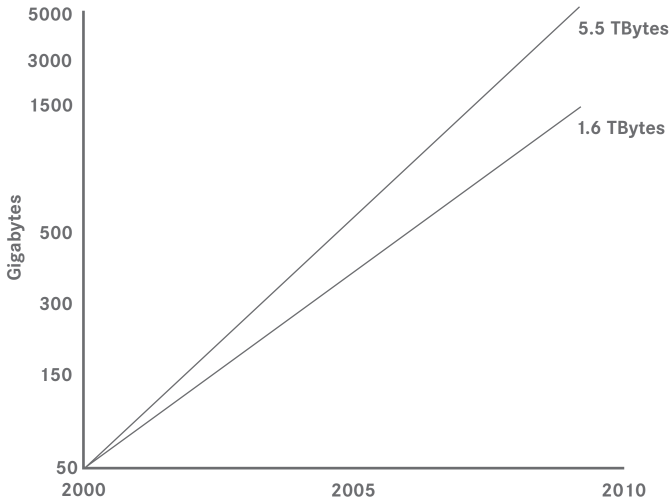
Hard disk drives

Hard disk drives (HDD) comprise an assembly stacking up to 12 rigid platters coated with magnetic oxide, each capable of storing data on both sides. Each recording surface has an associated read/write head, and any one may be activated at a given instant. Disk drives give rapid access to vast amounts of data, are highly reliable as they have only two moving parts – the swinging head assembly and the spinning disk. They can be written and read millions of times. The use of disks to store audio, video and film images has changed many aspects of digital production editing and transmission.

For high capacity, disks pack data very tightly indeed. Areal density, the amount of data stored per unit area of the disk surface, is one measure of their technology. Currently available high capacity drives achieve an average of around 130 Gb per square inch, though much greater figures have been achieved in the lab – pointing to continuing capacity growth. For this the heads float only a few molecules off the disk surface, so that even minute imperfections in the surface can cause heating of the head assembly. As a result, high capacity disk drives have to be handled with great care, especially when running. Vibration could easily send heads off-track or crashing into the disk surface – with possible terminal consequences.

In 2000 drive manufacturers predicted that, in this decade, development will continue at the same pace as the last. The graph shows this at both the 20-year historic rate of doubling every two years (41%/year) and the 60%/year achieved more recently. In early 2008 we are still almost tracking the 60% line and there was a slight slowdown to nearer 40%/year, due to hitting technical barriers such as the “superparamagnetic limit” – the limit of storing a bit of digital information in an ever-smaller area on hard disks. That has now been stepped around with perpendicular magnetic recording (PMR), laying tracks under one another. Current estimates are for this technology (along with all the other ones collected along the way) to produce a 3TB drive by 2010 in the popular 3.5-inch ‘desktop’ size. This fits with the first 1TB drive arriving in 2007 from Hitachi. Others will follow.

Disk drive capacity 2000-2010



The inventiveness of the hard disk drive technologists never flags. Another technology HAMR (heat-assisted magnetic recording) is expected to appear in product at or a bit beyond the end of this decade and may go on produce 50 Tb/square inch density sometime much later.

In general ever-higher capacities are still continuing to become available in smaller packages at lower cost per megabyte. Those currently available range from about 20 to 750 GB for 3.5-inch drives. The maximum sustained data rate, which is a factor of both data density along the tracks and rotational speed, is quoted up to 78 MB/s. Average rates are about 60 MB/s – and clearly enough to sustain uncompressed ITU-R BT.601 video. The 156 MB/s for HD requires the use of an array of disks. However most applications using compressed moving images can be run in realtime. For example, the image data for digital cinema is recommended by DCI to be a maximum of 250 Mb/s – about 32 MB/s.

While capacities grow and data transfers become faster, access time changes relatively little. Increases in the rotation speed from 7,200, to 10,000 and 15,000 RPM, have helped to reduce access times. For redundant storage and multi-channel bandwidth performance it is necessary to use specialist RAIDs. These will move on to handle more demanding requirements for multiple channels and high definition.

See also: RAID, SCSI
Website: www.seagate.com

HD

Short for HDTV.

HDCAM

Assigned D11, this is a series of Sony VTRs based on the Betacam principles for recording HD video on a tape format which uses the same style of cassette shell as Digital Betacam, although with a different tape formulation. The technology supports 1080-line standards. Various methods are believed to be used to reduce the video data including pre-filtering, DCT-based intra-frame compression and sampling at around 3:1:1. Together these are said to provide data reduction of between 7 and 10:1. Four non-compressed audio channels sampled at 48 kHz, 20 bits per sample, are also supported. One variation, CineAlta, is aimed at addressing the needs of digital cinematography.

HDCAM SR is further extension of Betacam recorders using mild MPEG-4 Studio Profile (SP) intra-frame compression to store full bandwidth 4:4:4 HD RGB 1080 and 720-line video offering more headroom for digital cinema users, as well as 4:2:2 Y,Pr,Pb component video for television. It offers video data rates of 440 Mb/s and 880 Mb/s, and more audio channels than other currently available. It is scalable in its pixel count (SDTV, HDTV, film-resolution data), bit depth (10- or 12-bit), and color resolution (component or RGB).

The Sony F950 camera provides suitable RGB sources for this, including undercranked footage. The close-to-raw-state RGB material is well suited to the needs of digital cinematography as the full latitude and bandwidth of the pictures is preserved through recording.

See also: 24PsF, CineAlta, D11
Website: www.sonybiz.net/hdcamsr

HDCP

High-bandwidth Digital Content Protection was designed by Intel to protect digital entertainment content across DVI or HDMI interfaces.

See also: HDMI
Website: www.digital-cp.com

HD D5

A D5 VTR adapted to handle high definition signals. Using around 5:1 compression the signals connect via an HD-SDI link. HD D5 can be multi-format, operating at both SD and HD TV standards. It can replay 525-line D5 as well as HD D5 cassettes. Formats include 480/60I, 1080/24P, 1080/60I, 1080/50I, 1035/59.94I and 720/60P. The recorder can also slew between 24 and 25 Hz frame rates for PAL program duplication from a 1080/24P master. Cassette recording times vary according to format, the longest is 155 minutes for 1080/24P.

Website: www.panasonic-broadcast.com

HD DVD

Designed as the successor to the standard DVD format HD DVD can store about three times as much data as its predecessor – 15 GB single layer, 30 GB dual layer. It is often called 3x DVD as it has three times the bandwidth (1x@36Mb/s and 2x@72Mb/s) and storage of regular DVDs. It supports encoding technologies: VC-1, AVC H.264, and MPEG-2, but almost all the early titles are encoded with VC-1, and most others with AVC.

For audio, mastering can be up to 7.1-channel surround sound. Linear PCM, DTS and all the Dolby formats (Dolby Digital, Dolby Digital Plus and Dolby TrueHD) are mandatory, meaning one of these can be used as the only soundtrack as every player has a decoder for any of these. It also supports DTS-HD High Resolution Audio and DTS-HD Master Audio. The reality is most early HD DVDs use 5.1 surround sound. HD DVD discs support audio encoding in up to 24-bit/192 kHz for two channels, or up to eight channels of up to 24-bit/96 kHz encoding. To date, even new big-budget Hollywood films are mastered in only 24-bit/48 kHz, while 16-bit/48 kHz is common for ordinary films.

Toshiba has shown a three-layer (45 GB) version at trade shows but this remains a lab project at present. The future for HD DVD is unclear as Blu-ray seems to have won the format war.

See also: DVD, Optical disks
Website: www.dvdforum.org

HDMI

The High-Definition Multimedia Interface is a digital audio and video interface able to transmit uncompressed streams. It is rapidly being adopted by both consumer and professional devices – from television sets, to set-top boxes, camcorders, game consoles and HD DVD/ Blu-ray Disc players. It replaces a pile of analog connections such as SCART, composite video, as well as DVI, audio and more. There is the current Type A standard 19-pin connector as well as a 29-pin Type B not yet in use. The early Version 1.1 specification supports the maximum pixel clock rate of 165 MHz, sufficient for1080/60P – beyond currently available television, and WUXGA (1920x1200) and 8-channel 192 kHz 24-bit audio as well as compressed streams such as Dolby Digital. The current HDMI 1.3 offers 340 MHz capability – beyond WQSXGA (3200 x 2048) giving it a high margin of future proofing.

Type A HDMI is backward-compatible with the video on single-link DVI-D, and DVD-I (not DVI-A) so a DVI-D source can drive an HDMI monitor, or vice versa, via an adapter, but without audio and remote control.

The data carried on HDMI is encrypted using High-bandwidth Digital Content Protection (HDCP) digital rights management technology – meaning that the receiving end needs to be able to decrypt HDCP. It is reported that all HDMI displays currently support HDCP and most DVI PC-style displays do not. In Europe the EICTA's 'HD-Ready' logo signifies a degree of future-proofing for HD.

HDR, HDRI

High Dynamic Range Imaging techniques allow a greater dynamic range of exposure than normally possible, with the intention of accurately representing the wide brightness range of real scenes ranging from direct sunlight to shadows. This is sometimes used with computer-generated images or photography (by taking several pictures of a scene over a range of exposure settings) and it can provide a large amount of headroom for the adjustment of images in post production.

HD ready

This describes a television that can display the recognized 720 and 1080-line formats but does not include the tuner or decoder needed to receive the signals.

HD RGB

This refers to HDTV signals in RGB form rather than Y,Cr,Cb form. The difference is that HD RGB is a 4:4:4 signal that can carry the full bandwidth of each of the R, G and B channels, whereas HD (TV) is normally considered to be in 4:2:2 form where the color difference signals have a more restricted bandwidth. Generally, the 4:2:2 form of HD is sufficient for many television applications and can be carried in its uncompressed form by a single HD-SDI connection. HD RGB is often used for critical keying shots for television, and for digital cinematography. The availability of a suitable VTR (HDCAM SR) makes working with the format generally more affordable.

HD-SDI

See SDI

HDTV

High Definition Television. A television format with higher definition than SDTV. While DTV at 625 or 525 lines is usually superior to PAL and NTSC, it is generally accepted that 720-line and upward is HD. This also has a picture aspect ratio of 16:9.

While there are many picture HDTV formats there is a consensus that 1080 x 1920 is a practical standard for global exchange of television material – a common image format. Many productions are made in this format.

See also: 24P, ATSC, Common Image Format, DVB, Table 3

HDV

High definition DV is a tape format that stores long GOP MPEG-2 encoded HD video onto DV or MiniDV tape cassettes. There are two standards. One is 1280 x 720 lines at 60, 50, 30 and 25P frame rates with a target compressed video rate of 19 Mb/s. The other is 1440 x 1080 lines at 50 and 60I interlaced vertical rate with a target bit rate of 25 Mb/s. All video sampling is 8-bit 4:2:0, 16:9 aspect ratio so the 1080-line format does not use square pixels. Audio is two channels of 48 kHz, 16-bit and uses MPEG-1 Layer 2 compression producing 384 kb/s total.

At its introduction in 2004, HDV represented a huge drop in price for HD camcorders. However the quality is 'prosumer' but it has opened up a new layer of operations for HD. Also the SD downconverted output is better than the usual SD DV results. The use of long GOP coding impedes frame-accurate editing.

See also: AVC-Intra

HE-AAC

See AAC, MPEG-4

Hexadecimal

A numbering system, often referred to as 'Hex', that works to base 16 and is particularly useful as a shorthand method for describing binary numbers. Decimal 0-9 are the same as Hex, then 10 is A, 11 is B, up to 15 which is F.

See also: Binary

Decimal	Binary	Hex
0-9	0-1001	0-9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F
16	10000	10
27	11011	1B
100	1100100	64
255	11111111	FF

HIPPI

High performance parallel interface (ANSI X3.283-1996). Capable of transfers up to 200 MB/s (800 with the 6400 Mb/s HIPPI, a.k.a. GSN) it is targeted at high performance computing and optimized for applications involving streaming large volumes of data rather than bursty network activity. The parallel connection is limited to short distance and so Serial HIPPI is now available (a.k.a. GSN).

See also: GSN
Website: www.hnf.org

H

History (editing)

A Quantel term describing the ability to instantly recall original material in uncommitted form along with the associated editing data. This allows any late changes to be made quickly and easily. For example, a shadow could be softened or moved in a multi-layered commercial without having to manually find the original material or recalling the set-up data. Archiving a program containing History means that the operator no longer needs to remember to save packs or set-ups associated with the job as all the material and set-ups will be automatically included within the history archive.

Holographic recording

A number of holographic recording systems are emerging as new ways of storing even more data onto 12 cm optical disks. 'Holographic' implies using optical techniques to record into the depth of the media, similar to modern high capacity hard (magnetic) disk drives that record successive tracks under one another below the disk's surface. Sony has announced work on data reading/writing using holographic Micro-Reflector recording technology: a holographic system relying on interference patterns between a read/record and a reference beam. It can store 1.25 GB in a single layer on the disk, but there can be 10 to 20 layers.

InPhase Technologies offers holographic recording through the depth of the disk allowing a 1.2 Mb 'page' of data to be written or read in one flash of light. First-generation holographic media has a capacity of 300 GB and a transfer rate of 20 MB/s (160 Mb/s), second generation will have a capacity of 800 GB and the third 1.6 TB.

Such specifications offer huge potential for many storage and replay applications including professional HD recording, archiving and, who knows, a replacement HD DVD/BD?

See also: HVD
Website: www.inphase-technologies.com

HSDL

The High Speed Data Link is typically used to move uncompressed 2K, 10-bit RGB images (as used for digital film) within a facility. The data volumes involved are very large; each image is 12 MB, and at 24 fps this data amounts to 288 MB/s.

HSDL provides an efficient transport mechanism for moving and sharing data between applications. It uses two SMPTE 292M 1.485 Gb/s serial links (HD-SDI) to provide nearly 3 Gb/s bandwidth and can result in close to realtime transfers at up to 15-20 f/s for 2K. Use of the SMPTE 292M data structure means the signal can be carried by the HD-SDI infrastructure – cabling, patch panels and routers that may already be in place for HD video.

Images carried on HSDL can be imported as data to a workstation fitted with dual HD-SDI making them available for film restoration, compositing, editing, and film recorders. Archiving and transporting HSDL material can be done with data tape such as DTF-2 or LTO.

See also: 2K, DTF, HD-SDI, LTO

HSM

Hierarchical Storage Management is a scheme responsible for the movement of files between archive and the other storage systems that make up hierarchical storage architecture. Typically there may be three layers of storage – online, near-line and offline – that make up the hierarchy that HSM manages. Managing these layers helps to run the archive and have the required speed of access to all stored material.

Hub (network)

Connects many network lines together as if to make them all part of the same wire. This allows many users to communicate but, unlike a switch, only one transaction can occur at once over the whole network.

See also: CSMA/CD, Switch

Huffman coding

This compresses data by assigning short codes to frequently occurring long sequences and longer ones to those that are less frequent. Assignments are held in a Huffman Table. Huffman coding is lossless and is used in video compression systems where it can contribute up to a 2:1 reduction in data.

See also: JPEG

H

HVD

Holographic versatile disk – a 'CD' sized (120mm diameter) optical disc that will be capable of storing up to 1 TB. In 2007, the HVD Forum developed three HVD standards including those for a 200 GB recordable and 100 GB ROM.

See also: Holographic recording
Website: hvd-forum.org

Hyperstereo (Stereoscopic)

Using widely spaced cameras (e.g. beyond 70mm interocular) which record more stereo effect than the eyes can see. Such a large interocular distance can produce the effect of miniaturization. Also used in order to achieve the effect of more stereo depth and less scale in a scene.

For stereo effects on very long shots (e.g. landscapes) interocular camera set ups of several meters have been used (hyperstereo). One extreme example of hyperstereo is from cameras on each side of the earth to record the sun in 3D.

See also: Miniaturization, Interocular

Hypostereo (Stereoscopic)

Using closely spaced cameras (e.g. less than 50 mm interocular) which record less stereo effect than the eyes can see. Such a small interocular distance can produce the effect of gigantism. If standard cameras are used, the minimum interocular distance is typically limited by the thickness of the cameras so a mirror or beam splitter system is often used, enabling interoculars down to millimeters.

See also: Gigantism

IDTV

Integrated Digital TV receiver. For viewers to receive DTV services they require a receiver either in the form of a new television set with the tuner and digital decoder built in (IDTV) or a set-top box. IDTVs typically include provision for all widely available terrestrial DTV services, so cable and satellite still require a set-top box. Note that although the set may be able to receive HD the screen may not be able to display the full sized 1080 x 1920 HD. In this case processing is included to re-size the pictures to fit the screen.

See also: IRD, Table 3

IEEE 802.3

Standard that defines wired Ethernet.

See: grouper.ieee.org/groups/802/3/index.html

IEEE 1394 (a.k.a. FireWire, I-Link)

A standard for a peer-to-peer serial digital interface which can operate at 100, 200, 400 or 800 Mb/s. IEEE 1394a specifies working up to 400 Mb/s, typically over copper cables up to 4.5 meters in length with six-pin connectors. Consumer devices use a four-pin connector. Extenders increase the maximum distance from 4.5 meters on copper cables up to about 100 meters on glass optical fiber.

IEEE 1394b extends both data rate and distance: up to 1.6Gb/s on shielded twisted pair cable up to 4.5m, and has architecture to support 3.2Gb/s over 100m on optical fiber. Practically it can send A/V media over 100m of Cat-5 cable at 100 Mb/s. Consumers connect DV devices over longer distances using readily available low cost cables. IEEE 1394c has a data rate to 800 Mb/s over Cat5 cable and combines 1394 and GigE on one cable.

High speed and low cost of IEEE 1394a and b make it popular in multimedia and digital video applications. Uses include peer-to-peer connections for digital dub editing between camcorders, as well as interfacing VCRs, printers, PCs, TVs and digital cameras.

IEEE 1394 is recognised by SMPTE and EBU as a networking technology for transport of packetized video and audio. Its isochronous data channel can provide guaranteed bandwidth for frame-accurate realtime (and faster) transfers of video and audio while its asynchronous mode can carry metadata and support I/P. Both modes may be run simultaneously.

See also: Asynchronous, Isochronous
Website: www.1394ta.org

I-frame only (a.k.a. I-only)

A video compression scheme in which every frame is intra-frame (I-frames) compressed, i.e. individually defined and does not depend on any other frames for decoding. There are no P (predictive) or B (bi-directional) frames in such compression schemes. This is considered preferable for studio use as edits can be made on any frame boundaries without necessarily involving processing.

All DV compression is I-frame only. MPEG-2 and MPEG-4 with a GOP of 1 is I-frame only. For example these are used in Sony's IMX VTRs and HDCAM SR respectively. JPEG 2000 is I-frame only.

See also: Cut (edit), D11, GOP, Intra-frame (compression), JPEG 2000, MPEG-2, MPEG-4

I

I-Link

See IEEE 1394

Illegal colors

Colors that lie outside the limits, or gamut, of a particular color space. These can be generated when moving images from one color space to another, as they all have different boundaries, or as the result of color processing. For example, removing the luminance from a high intensity blue or adding luminance to a strong yellow in a paint system may well send a subsequent PAL or NTSC coded signal too high or low – producing at least inferior results and maybe causing technical problems. Out-of-gamut detectors can be used to warn of possible problems and correction is also available. Some broadcasters reject material with illegal colors.

IMX

See D10

InfiniBand

InfiniBand defines an input/output architecture that can connect servers, communications infrastructure equipment, storage and embedded systems. It can achieve data transfers up to 120GB/s over copper and optical fiber connections, with the benefits of low latency and only requiring a low processing overhead. It is used in many data centers, high-performance computer clusters and embedded applications that scale from two nodes up to a single cluster that interconnect thousands of nodes.

ING

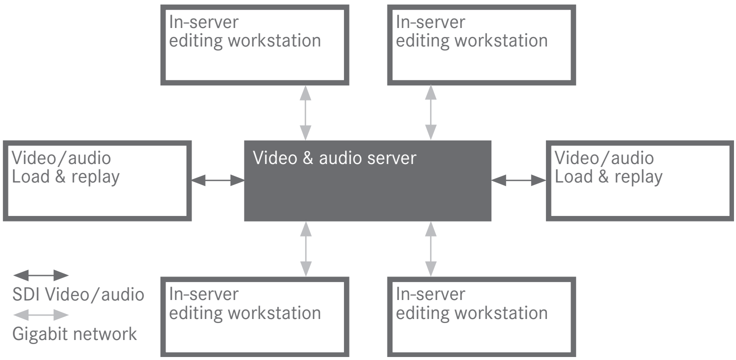
IT-News Gathering – coined by Panasonic to highlight their use of Secure Data (SD) memory as the in-camera media store for their DVCPRO P2 (P2 Cam) news cameras.

See also: DV, ENG

In-server editing

Editing at a workstation which directly edits material stored in a server. For this the workstation does not need large-scale video and audio storage but depends totally on the server store. The arrangement allows background loading of new material, via several ports if required, and playout of finished results, while avoiding any need to duplicate storage or transfer material to/from the workstation and allowing any number of connected workstations to share work. The efficiency of in-server editing allows fast throughput and is specially attractive to news as well as to post production where jobs can be instantly available in rooms, or move between rooms.

This depends on using a server that can act as an edit store and perform reliable video replay and record. It also requires a powerful interface to the edit workstation. Quantel's edit workstations with sQ servers that can operate this way. The workstation/server connection is by Gigabit Ethernet.



See also: Delta editing

Interactive Television (iTV)

A service that may be enabled with DTV which allows viewers to participate or access more information about the program. The interactivity may be implemented by selecting different TV channels (unknown to the viewer) or by a return control path to the service provider. Besides using a phone line, DVB has devised return control paths for satellite (DVB-RCS), cable (DVB-RCC) and terrestrial (DVB-RCT). Some consider interactivity is the future of television – the 'killer app(lication)' that will make DTV a commercial success. Others talk of lean back (viewing) and lean forward (interaction) being very different attitudes of both body and mind and question whether the two belong in the same place.

See also: Return control

Inter-frame (compression)

Compression which involves more than one frame. Inter-frame compression compares consecutive frames to remove common elements and arrive at 'difference' information to describe frames between I-frames. MPEG-2 and MPEG-4 use two types of inter-frame processed pictures – the 'P' (predictive) and 'B' (bi-directional) frames. As 'P' and 'B' frames are not complete in themselves but relate to other adjacent frames, they cannot be edited independently.

See also: Cut edit, MPEG-2, MPEG-4

Interlace Factor

I

The reduction in vertical definition during vertical image movement due to interlaced (rather than progressive) scans. Experimentally it is found to be about 30%. Note that, when scanning film frame-per-frame (i.e. 24 or 25fps – not 3:2 pull-down to 60fps), or a succession of electronic frames each representing a single snapshot in time, there is no vertical movement between fields and the Interlace Factor has no effect.

See also: 24PsF

Interlace (scan)

Method of scanning lines down a screen (vertical refresh) – as used in most of today's television broadcasts and originally designed to suit the needs of CRT displays and analog broadcasts. Interlace is indicated in television scan formats by an 'I' e.g. 1080I, etc. Each displayed picture comprises two interlaced fields: field two fills in between the lines of field one. One field displays odd lines, then the other shows even lines. For analog systems, this is the reason for having odd numbers of lines in a TV frame eg 525 and 625, so that each of the two fields contain a half-line, causing the constant vertical scan to place the lines of one field between those of the other.

The technique greatly improves the portrayal of motion and reduces picture flicker without having to increase the picture rate, and therefore the bandwidth or data rate. Disadvantages are that it reduces vertical definition of moving images by about 30% (see Interlace Factor) of the progressive scan definition and tends to cause some horizontal picture detail to 'dither' – causing a constant liveliness even in still pictures.

Interlaced video requires extra care for processing, such as in DVE picture size changes, as any movement between fields has to be detected if the higher-quality frame-based processing is used. Also frame freezes and slow motion need 'de-interlace' processing.

There is continuing debate about the use of interlaced and progressive scans for DTV formats. This has intensified now that the increasingly popular panel displays are all progressive.

See also: Interlace Factor, Progressive

Internegative

As a part of the chemical lab film intermediate process internegatives are created by contact printing from interpositives. These very much resemble the cut negative. The stock is the same as for interpositives: slow, very fine grain with a gamma of 1, and the developed film is orange-based. To increase numbers, several internegatives are copied from each interpositive. These are then delivered to production labs for large scale manufacture of release prints.

See also: Film basics (Tutorial 2)

Interocular distance (Stereoscopic)

The distance between the centers of the lenses of two recording cameras. A typical distance would be 63.5 mm (approximating average adult eye spacing).

The term 'interaxial' is sometimes also used interchangeably with 'interocular' (when referring to eyesight, 'interpupillary' is often used).

Interoperability

The ability of systems to interoperate – to understand and work with information passed from one to another. Applied to digital media this means video, audio and metadata from one system can be used directly by another. Digital signals may be originated in various formats and subjected to different types of compression so care is needed to maintain interoperability.

Interpositive

This is a first part of the chemical lab intermediate process where a positive print of film is produced from the cut (edited) camera negative. Interpositives are made by contact printing onto another orange-base stock. In order to preserve as much detail as possible from the negative, including its dynamic range, interpositive material is very fine grain, slow and has a gamma of 1. During the copying process, grading controls are used to position the image density in the center of the interpositive material's linear range. As a part of the process of going from one camera negative to, possibly, thousands of prints, a number of interpositives are copied from the negative.

See also: Film basics (Tutorial 2)

Interpolation (spatial)

Defining the value of a new pixel from those of its near neighbors. When re-positioning or re-sizing a digital image, for dramatic effect or to change picture format, more, less or different pixels are required from those in the original image. Simply replicating or removing pixels causes unwanted artifacts. For far better results the new pixels have to be interpolated – calculated by making suitably weighted averages of adjacent input pixels – to produce a more transparent result. The quality of the results will depend on the techniques used (bi-cubic is generally accepted as being good) and the number of pixels (points) taken into account (hence 16-point interpolation), or area of original picture, used to calculate the result.

See also: Anti-aliasing, Interpolation (temporal), Sub-pixel

Interpolation (temporal)

Interpolation between the same point in space (pixel) on successive frames. It can be used to provide motion smoothing and is extensively used in standards converters to reduce the judder caused by field rate changes – such as between 50 and 60 Hz. The technique can also be adapted to create frame averaging for special effects and slow motion. Various qualities of processing are used. It can be very complex, attempting to work out how each element in successive pictures is moving in order to synthesis 'between' images.

Intra-frame (compression)

Compression that occurs within one frame. The compression process only removes redundant and visually less significant information from within the frame itself. No account is taken of other frames. JPEG and the 'I' frames of MPEG-2 are coded in this way and use DCT. In the MPEG-2 sequence only I-frames can be edited as they are only independent frames.

See also: DCT, I-frame only, JPEG, MPEG-2

I-only

See: I-frame only

IP

Internet Protocol is the de facto standard for networking and is the widest used of the network protocols that carry the data and lie on top of physical networks and connections. Besides its Internet use it is also the main open network protocol that is supported by all major computer operating systems. IP, or specifically IPv4, describes the packet format for sending data using a 32-bit address to identify each device on the network with four eight-bit numbers separated by dots e.g. 192.96.64.1. Each IP data packet contains a source and destination address. There is now a move toward IPv6 which brings, among many other enhancements, 128-bit addressing – enough for over 6,000 billion devices and relieving IPv4's address shortage.

Above IP are two transport layers. TCP (Transmission Control Protocol) provides reliable data delivery, efficient flow control, full duplex operation and multiplexing (simultaneous operation with many sources and destinations). It establishes a connection and detects corrupt or lost packets at the receiver and re-sends them. Thus TCP/IP, the most common form of IP, is used for general data transport but is slow and not ideal for video.

UDP (User Datagram Protocol) uses a series of 'ports' to connect data to an application. Unlike the TCP, it adds no reliability, flow-control or error-recovery functions but it can detect and discard corrupt packets by using checksums. This simplicity means its headers contain fewer bytes and consume less network overhead than TCP, making it useful for streaming video and audio where continuous flow is more important than replacing corrupt packets.

There are other IP applications that live above these protocols such as File Transfer Protocol (FTP), Telnet for terminal sessions, Network File System (NFS), Simple Mail Transfer Protocol (SMTP) and many more.

Website: www.ipv6forum.com

IP Datacast Forum (IPDC)

The IPDC Forum was launched in 2002 to promote and explore the capabilities of IP-based services over digital broadcast platforms (DVB and DAB). Participating companies include service providers, technology providers, terminal manufacturers and network operators. The Forum aims to address business, interoperability and regulatory issues and encourage pilot projects.

See also: IP over DVB
Website: www.ipdc-forum.org

IP over DVB

The delivery of IP data and services over DVB broadcast networks. Also referred to as datacasting, this takes advantage of the very wideband data delivery systems designed for the broadcast of digital television, to deliver IP-based data services – such as file transfers, multimedia, Internet and carousels, which may complement, or be instead of, TV.

Due to DVB-T's ability to provide reliable reception to mobile as well as fixed receivers, a new standard DVB-H has been added to send IP-style service to people on the move – typically to phones. For interactivity, a return path can be established by the phone.

See also: IP Datacast Forum, Data carousel, IP over DVB

I

IPTV

Internet Protocol Television is the use of the IP packetized data transport mechanism for delivery of streamed realtime television signals across a network.

IRD

Integrated Receiver Decoder. A device that has both a demodulator and a decoder (e.g. for MPEG-2) built in. This could be a digital television set or a digital set-top box.

See also: IDTV

ISA

Integrated Server Architecture is a Quantel term for the technology used in its sQ servers to manage the contents of several separate servers simultaneously. ISA operates at two levels one locks browse and full quality material together under a single ISA database, the other allows all material held on several sQ servers to be handled as if on a single server – effectively as if on a single database. This facilitates system scaling of users and storage by adding servers and makes possible the ZoneMagic operation where two separated servers are kept in step.

See also: NAS, SAN

ISDB

Integrated Services Digital Broadcasting – standard for digital broadcasting used in Japan. ISDB has many similarities to DVB including OFDM modulation for transmission and the flexibility to trade signal robustness against delivered data rate. ISDB-T (terrestrial) is applicable to all channel bandwidth systems used worldwide – 6, 7, and 8 MHz. The transmitted signal comprises OFDM blocks (segments) allowing flexible services where the transmission parameters, including modulation and error correction, can be set segment-by-segment for each OFDM segment group of up to three hierarchical layers in a channel. Within one channel, the hierarchical system allows both robust SD reception for mobile and portable use and less robust HD – a form of graceful degradation.

See also: COFDM, DiBEG, DVB
Website: www.dibeg.org

ISO

International Standards Organization. An international organization that specifies international standards, including those for networking protocols, compression systems, disks, etc.

See: Directory
Website: www.iso.ch

Isochronous

A form of data transfer that carries timing information with the data. Data is specified to arrive over a time window, but not at any specific rate within that time. ATM, IEEE 1394 and Fibre Channel can provide isochronous operation where links can be booked to provide specified transfer performance. For example, 60 TV fields can be specified for every second but their arrival may not be evenly spread through the period. As this is a guaranteed transfer it can be used for 'live' video but is relatively expensive on resources.

See: ATM, Asynchronous, Fibre Channel, IEEE 1394, Synchronous

ITU

International Telecommunications Union. The United Nations regulatory body covering all forms of communication. The ITU sets mandatory standards and regulates the radio frequency spectrum. ITU-R (previously CCIR) deals with radio spectrum management issues and regulation while ITU-T (previously CCITT) deals with telecommunications standardization. Suffix BT. denotes Broadcasting Television.

See: Directory
Website: www.itu.ch

I

ITU-R BT.601

This standard defines the digital encoding parameters of SD television for studios. It is the international standard for digitizing component television video in both 525 and 625 line systems and is derived from SMPTE RP125. ITU-R BT.601 deals with both color difference (Y, R-Y, B-Y) and RGB component video and defines sampling systems, RGB/Y, R-Y, B-Y matrix values and filter characteristics. It does not actually define the electro-mechanical interface – see ITU-R BT. 656.

ITU-R BT.601 is normally taken to refer to color difference component digital video (rather than RGB), for which it defines 4:2:2 sampling at 13.5 MHz with 720 (4) luminance samples per active line. The color difference signals R-Y and B-Y are sampled at 6.75 MHz with 360 (2) samples per active line. Its depth may be 8 or 10 bits.

Some headroom is allowed so, with 10-bit sampling, black level is at 64 (not 0) and white at level 940 (not 1023) – to minimize clipping of noise and overshoots. With 2^{10} levels each for Y (luminance), Cr and Cb (the digitized color difference signals) = 2^{30} – over a billion unique colors can be defined.

The sampling frequency of 13.5 MHz was chosen to provide a politically acceptable common sampling standard between 525/60 and 625/50 systems, being a multiple of 2.25 MHz, the lowest common frequency to provide a static sampling pattern for both.

See also: 13.5 MHz, 4:2:2, Frequency, Into digits (Tutorial 1)

ITU-R BT.656

The international standard for interconnecting digital television equipment operating to the 4:2:2 standard defined in ITU-R BT.601. It defines blanking, embedded sync words, the video multiplexing formats used by both the parallel (now rare) and serial interfaces, the electrical characteristics of the interface and the mechanical details of the connectors.

ITU-R BT.709

In 2000, ITU-R BT.709-4 recommended the 1080 active line standard for 50 and 60 Hz interlace scanning with sampling at 4:2:2 and 4:4:4. Actual sampling rates are 74.25 MHz for luminance Y, or R, G, B and 37.125 MHz for color difference Cb and Cr, all at 8 bits or 10 bits, and these should be used for all new productions. It also defines these 1080-line square-pixel standards as a common image formats (CIF) for international exchange.

The original ITU-R BT.709 recommendation was for 1125/60 and 1250/50 (1035 and 1152 active lines) HDTV formats defining values and a '4:2:2' and '4:4:4' sampling structure that is 5.5 times that of ITU-R BT.601. Note that this is an 'expanded' form of 601 and so uses non-square pixels.

See also: Common Image Format

ITU-R/BT.799

See Dual link

iTV

See: Interactive Television

Java

A general purpose programming language developed by Sun Microsystems and best known for its widespread use in animations on the World Wide Web. Unlike other software, programs written in Java can run on any platform type, so long as they have a Java Virtual Machine available.

Website: java.sun.com

I
J

JPEG (.JPG)

Joint Photographic Experts Group (ISO/ITU-T). They have defined a compression known as JPEG which is a DCT-based data compression standard for still pictures (intra-frame). It offers compression of between two and 100 times and three levels of processing are defined: the baseline, extended and lossless encoding.

JPEG baseline compression coding, which is overwhelmingly the most common in both the broadcast and computer environments, starts with applying DCT to 8 x 8 pixel blocks of the picture, transforming them into frequency and amplitude data. This itself may not reduce data but then the generally less visible high frequencies can be divided by a high 'quantizing' factor (reducing many to zero), and the more visible low frequencies by a much lower factor. The 'quantizing' factor can be set according to data size (for constant bit rate) or picture quality (constant quality) requirements – effectively adjusting the compression ratio. The final stage is Huffman coding which is lossless but can further reduce data by 2:1 or more.

Baseline JPEG coding creates .jpg files and it is very similar to the I-frames of MPEG, the main difference being they use slightly dissimilar Huffman tables.

See also: Compression, Compression ratio, DCT, Huffman coding, MPEG
Website: www.jpeg.org

JPEG 2000 (.JP2)

This is an image coding system that is totally different from the original JPEG as it is based on different principles. Whereas JPEG is DCT-based and examines images in a series of 8 x 8 pixel blocks, JPEG 2000 is wavelet-based – analyzing pictures in circular areas. Both coding and decoding require far more processing than MPEG-2 and MPEG-4. Also JPEG 2000 is intra-frame only, there are no predictive frames (as in MPEG). Whereas MPEG tends to show blocks as it fails, and the original JPEG shows 'mosquito wings' or ringing effects, JPEG 2000 knows nothing of blocks and a failure, running out of data space, can cause a softening of picture areas, which is far less noticeable.

JPEG 2000 is about twice as efficient as the equivalent I-only MPEG-2, and excels at high bit rates and is used at up to 250Mb/s for DCI Digital Cinema applications, showing 24 pictures per second. It lends itself to a wide range of uses from portable digital cameras through to advanced pre-press, television acquisition and Digital Cinema. Some expect it to become the favored compression system for TV distribution.

Website: www.jpeg.org

JBOD

Just a bunch of disks. This could be a collection of disk drives connected on a single data bus such as SATA, Fibre Channel or SCSI. JBODs are cheap and can offer large volumes of storage that may be shared among their users. As there are no intelligent controllers, items such as data speed and protection may well be compromised.

See also: SAN

Keycode

A machine-readable barcode printed along the edge of camera negative film stock outside the perforations. It gives key numbers, film type, film stock manufacturer code, and offset from zero-frame reference mark (in perforations). It has applications in telecine and film scanning for accurate film-to-tape or data transfer and in editing for conforming neg. cuts to EDLs.

Keyframe

A set of parameters defining a point in a transition, e.g. of a DVE effect. For example a keyframe may define a picture size, position and rotation. Any digital effect must have a minimum of two keyframes, start and finish, although complex moves will use more – maybe as many as 100.

Increasingly, more parameters are becoming 'keyframeable', i.e. they can be programmed to transition between two, or more, states. Examples are color correction to make a steady change of color, and keyer settings, perhaps to make an object slowly appear or disappear.

See also: DVE

Keying

The process of selectively overlaying an area of one picture (or clip) onto another. If the switch between the overlaid and background pictures is simply ‘hard’ this can lead to jagged edges of the overlaid, or keyed, pictures. They are usually subjected to further processing to produce ramped, slightly soft, key edges to give a cleaner, more convincing, result. The whole technology of deriving key signals from image data and the color corrections applied to keyed image edges, has greatly expanded through the use of digital technology, so that many operations may be used together, e.g. softening the key, color correcting key spill areas, and much more.

See also: Chroma keying, Digital keying, Linear keying

Keystoning (Stereoscopic)

The result arising when the film plane in a camera or projector is not parallel to the view or screen, leading to a trapeze shape. On a stereoscopic image, where the cameras are ‘toed-in’ so that the object of interest coincides when viewed, there can be some mismatching of the outlines or borders of the two images. Techniques like corner pinning can be used to help correct this.

KLV

KLV is a data encoding protocol (SMPTE 336M). The Key is a unique, registered sequence of bits that defines the type of content that is coming (video, audio, EDL, etc) and Length – number of bytes ahead of Value, the content ‘payload’ itself. Compliance to KLV means that a wider range of equipment and applications can understand each other’s files.

See also: AAF, MXF

LAD

Laboratory Aim Density is a quality control method to maintain consistency in film prints. To aid in color timing, original negatives are timed relative to a LAD Control Film which includes reference patches and a figure of a girl (Marcie). There are differing LAD values for each type of print or duplication film that the original will be printed on.

Latency (of data)

The delay between requesting and accessing data. For disk drives it refers to the delay due to disk rotation only – even though this is only one of several factors that determines time to access data from disks. The faster a disk spins the sooner it will be at the position where the required data is under the replay head. As disk diameters have decreased so rotational (spindle) speeds have tended to increase but there is still much variation. Modern 3.5-inch drives typically have spindle speeds of between 7,200 and 10,000 RPM, so one revolution is completed in 8 or 6 ms respectively. This is represented in the disk specification as average latency of 4 or 3 ms. It is reduced to 2 ms in the faster drives operating at 15,000 RPM.

Latitude

Latitude is the capacity of camera negative film (especially) to hold information over a wider brightness range than is needed for the final print. This provides a degree of freedom that is needed because it is impossible to see if the exposure is totally correct until the film comes back from the laboratory – long after the set has been struck and everyone has gone home. Latitude provides room for later adjustment in printing to compensate for over or under exposure. This contrasts with using digital cinematography where it is possible to see the results immediately and make any required adjustment at the shooting stage. This procedure can reduce the need for a very wide latitude (which cannot extend to the release prints) by ensuring the lighting and camera set ups are always correct at the shoot.

See also: Camera negative

Layer(ing)

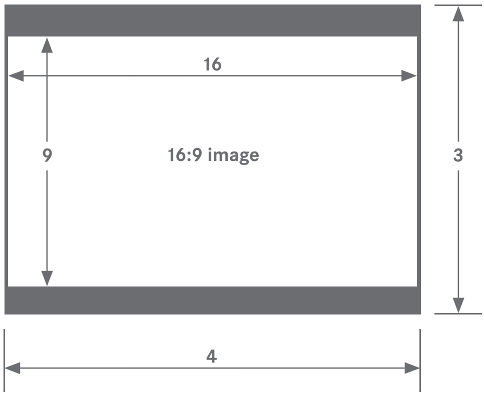
A collection, or 'pack' of clip layers can be assembled to form a composite layered clip. Layers may be background video or foreground video with their associated matte run. The ability to compose many layers simultaneously means the result can be seen as it is composed and adjustments made as necessary.

LCOS

Liquid Crystal On Silicon – an imaging chip technology that has been likened to a cross between LCD and DLP. Like LCDs this uses one liquid crystal per pixel to control the light, but whereas LCD is transmissive, the light travels through the crystals, LCOS is reflective, like DLP. LCOS is the basis for many imagers, JVC's implementation is D-ILA and Sony's SXRG appear to use similar some ideas – though many refinements are used.

Letterbox

A method used to show higher aspect ratio (e.g. 16:9) images on a low aspect ratio (e.g. 4:3) display. While all the contents of the pictures can be seen there are strips of (usually) black above and below the picture which some people do not like.



See also: 14:9, Anamorphic, ARC

Level

See MPEG-2

Lights

See Printer lights

Linear (editing)

The process of editing footage that can only be accessed or played in the sequence recorded. Tape and film are linear in that they have to be spooled for access to any material and can only play pictures in the order they are recorded.

With spooling, jogging and pre-rolls, so called 'mechanical considerations', absorbing upwards of 40 percent of the time in a VTR edit suite, linear editing is slow for everyday editing. The imposition of having to record items to an edit master tape in sequence limits flexibility for later adjustments: e.g. inserting shots between existing material may involve either starting the job again or re-dubbing the complete piece. For simple changes however, linear suites are still fast for tape-based material.

See also: C-mode, Digital disk recorder, True random access

Linear (keying)

In linear keying the ratio of foreground to background pictures at any point on the screen is determined on a linear scale by the level of the key (control) signal.

This form of keying provides the best possible control of key edge detail and anti-aliasing. It is essential for the realistic keying of semi-transparent effects such as transparent shadows, through-window shots and partial reflections.

See also: Keying

LSB

See Digit

LTC

Longitudinal Timecode. Timecode recorded on a linear track on tape and read by a static head. This can be easily read when the tape is moving forwards or backwards but not at freeze frame – when VITC, timecode recorded with the picture material, can be used.

L

See also: VITC

LTO-2, LTO-3

Data storage formats from Quantum using linear, not helical, recording technology. Used for data archive and transfer, these perform lossless compression on the data and are currently quoted as storing up to 800GB on a single tape cartridge and replay at up to 245 GB/h – based on a 2:1 lossless compression ratio.

See also: DTF, SAIT-2
Website: www.quantum.com

Luminance

A component of video: the black and white or brightness element, of an image. It is written as Y, so the Y in Y,B-Y,R-Y, YUV, YIQ and Y,Cr,Cb is the luminance information of the signal.

In a color TV system the luminance signal is usually derived from the RGB signals, originating from cameras or telecines, by a matrix or summation of approximately:

Y = 0.3R + 0.6G + 0.1B (based on ITU-R BT.601)

See also: Coded, RGB, Y (B-Y) (R-Y), Y,Cr,Cb, YUV

LUT

Look-up table. This is a table of multipliers used to convert values from one type of digital scale to another. The LUT will contain a distinct multiplying value for every input digital value. For example, a LUT can be used to convert brightness values measured by an electronic sensor, which will be linear, to logarithmic values which more accurately reflect our perception – and the way film responds to light. As modern post production equipment is expected to work across media – film, TV, DVD, D-cinema, etc., there is increasing need for conversions using LUTs to suit differences in color space between display systems (CRTs, DLPs, etc.) as well as in the media themselves.

A 1D LUT maps one input value to a new output value; gamma changes can be implemented with a 1D LUT. A 3D LUT maps three input values to a new output value. 3D LUTs are widely used for print matching and X'Y'Z' colorspace transforms where the output of, say, the R value depends on the input R, G and B values. Thus three 3D LUTs are required for full colorspace transforms.

See also: Color cube

Macroblock

See MPEG-2

MADI

Multichannel Audio Digital Interface, widely used among audio professionals, defines the data format and electrical characteristics of an interface carrying multiple digital audio channels – as in AES10-2003. It is popular for its large channel capacity – 28, 56, or 64 channels at up to 96 kHz, 24 bits per channel, and up to 3000m connections over optical fiber (or 100m over coax).

MAM

Media Asset Management is used in modern broadcast and post production that increasingly depends on file-based operation rather than the use of tape. MAM can track and manage all aspects of the use and repurposing of media assets so it is clear which assets have been used where. This can help both in technical operations such as adjusting an edit, as well as commercial requirements such as billing.

Main (Level/Profile) (ML) (MP)

See MPEG-2

Master

The master of an edited program holds the material that is used as the source for making all deliverables and other versions (for language, subtitles etc.). Making a good quality master helps to ensure that the deliverables are good.

For international distribution the use of 1080 x 1920 24P is generally regarded as the best to ensure good quality deliverables for HD as well as SD requirements. However supplying the best to all media platforms now often requires more than the traditional master can provide. A better form of master may be an uncommitted one, where all the original source material and all the tools used and their settings, are available so that any aspect of editing and finishing can be revisited to make the right best deliverables for everyone.

See also: Deliverables

MediaFLO

A mobile TV system offered by Qualcomm. The system, comprising the MediaFLO Media Distribution System and FLO™ Technology, is designed to optimize the delivery of multimedia and address the needs of mobile content delivery – typically to mobile phones.

See also: DVB-H, DMB

Metadata

Data about data. It is data about the video and audio but not the actual video or audio themselves. This is important for labeling and finding data – either in a 'live' data stream or an archive. Within studios and in transmission, digital technology allows far more information to be added. Some believe metadata will revolutionize every aspect of production and distribution. Metadata existed long before digital networks; video timecode and film frame numbers are but two examples. Today the metadata can also include the detail about the editing, color correction and effects work. Such history information allows a more open choice of equipment and the ability to retrace the detail of post production – should any changes be required.

See also: AAF, Content, Essence, History, MXF

Middleware

Software, not hardware. This exists above the operating system to provide a middle layer offering APIs for applications programmers but it is not an application itself. An example is Multimedia Home Platform (MHP) which is widely used in set-top boxes.

Miniaturization (Stereoscopic)

Confusing visual cues in a stereoscopic scene that can make an object appear to be the 'wrong' size i.e. the impression of being strangely reduced in size. This is due to the choice of an interaxial distance of greater than 63.5 mm relative to the focal length of the camera lenses e.g. shooting with very widely spaced cameras. Subjectively this makes the audience feel like a giant looking at tiny objects, which is why miniaturization is sometimes referred to as Lilliputianism.

See also: Gigantism, Interocular

Mobile TV

This is where broadcasters and mobile (cell) telcos are coming together to allow consumers to access video content on their mobile phones. This includes downloads to flash memory, 3G streaming and mobile digital broadcast TV. The landscape is complex as there are many competing formats including DVB-H, DVB-SH, MediaFLO, ISDB-T, S-DMB/T-DMB in different regions and backed by different hardware manufacturers, technology suppliers, content providers and mobile operators. China is adding its homegrown China Multimedia Mobile Broadcasting (CMMB). In Europe, the European Union has decided to support the DVB-H standard for mobile TV. DVB-H uses a separate broadcast network, rather than a phone network, to send TV content to phones or mobile devices.

Modem

Short for modulator/demodulator, it is a two-way communications interface working between a communications channel, such as a DSL line, and a machine – such as a computer.

Moore's Law

A prediction for the rate of development of modern electronics. This has been expressed in a number of ways but in general states that the density of information storable in silicon roughly doubles every year. Or, the performance of silicon will double every eighteen months, with proportional decreases in cost. For more than two decades this prediction has held true.

Moore's Law initially talked about silicon but it could be applied to other aspects such as disk drive capacity that doubles every two years and has held true, or been exceeded, since 1980, and still continues unabated.

See: Disk drives

Moiré

Refers to a distortion that appears as patterning seen on images where two similar fine patterns overlap, for example two fine gratings can appear to produce diagonal lines. The affect can appear even when one to the patterns is normally invisible, such as the sampling frequency of the image. In a good image system this should be avoided by use of filters but, for instance, the fine detail of a grid pattern may suddenly collapse and appear as curves or diagonal lines as the camera zooms in and the pattern detail nears the digital sampling frequency.

MOS

Media Object Server (protocol) – a communications protocol for newsroom computer systems (NCS) and broadcast production equipment. It is a collaborative effort between many companies to enable journalists to see, use, and control a variety of devices from their desktop computers, effectively allowing access to all work from one screen. Such devices include video and audio servers and editors, still stores, character generators and special effects machines.

MOS uses a TCP/IP-based protocol and is designed to allow integration of production equipment from multiple vendors with newsroom computers via LANs, WANs and the Internet. It uses a 'one-to-many' connection strategy – multiple MOSs can be connected to a single NCS, or a single MOS to many NCSs.

Website: www.mosprotocol.com

Motion vectors

See MPEG-2

MP3

A high-performance, perceptual audio compression coding scheme which exploits the properties of the human ear and brain while trying to maintain perceived sound quality. MPEG-1 and 2 define a family of three audio coding systems of increasing complexity and performance – Layer-1, Layer-2 and Layer-3. MP3 is shorthand for Layer-3 coding. MPEG defines the bitstream and the decoder but, to allow for future improvements, not an encoder. MP3 is claimed to achieve 'CD quality' at 128-112 kb/s – a compression of between 10 and 12:1.

See also: Auditory masking
Website: www.mp3-tech.org

MP@ML, MP@HL

See MPEG-2

MPEG – general

Moving Picture Experts Group. This a working group of ISO/IEC for the development of international standards for compression, decompression, processing, and coded representation of moving pictures, audio and their combination. It has also extended into metadata. Four MPEG standards were originally planned but the accommodation of HDTV within MPEG-2 has meant that MPEG-3 is now redundant. MPEG-4 is very broad and extends into multimedia applications. MPEG-7 is about metadata and MPEG-21 describes a 'big picture' multimedia framework.

Websites: www.chiariglione.org/mpeg
www.mpeg.org
www.mpegif.org

MPEG-1

A compression scheme designed to work at 1.2 Mb/s, the basic data rate of CD-ROMs, so that video could be played from CDs. Its quality is not sufficient for TV broadcast.

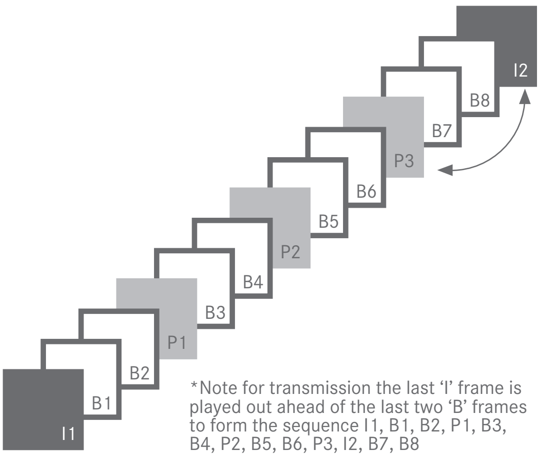
MPEG-2

ISO/IEC 13818. A family of inter- and intra-frame compression systems designed to cover a wide range of requirements from 'VHS quality' all the way to HDTV through a series of compression algorithm 'profiles' and image resolution 'levels'. With data rates from below 4 to 100 Mb/s, this family includes the compression system that currently delivers digital TV to homes and that puts SD video onto DVDs as well as putting HD onto 6.35mm tape for HDV.

In all cases MPEG-2 coding starts with analyzing 8x8-pixel DCT blocks and applying quantizing to achieve intra-frame compression very similar to JPEG. That produces I-frame only MPEG-2 video. Producing much higher compression involves analyzing the movement of 16x16-pixel macroblocks frame-to-frame to produce vectors to show the distance and direction of macroblock movement. Their correctness is a big factor in coders' quality and efficiency. This vector data is carried in the P (predictive) and B (bi-directional predictive) frames that exist between I frames (see diagram). SDTV transmissions and DVDs typically contain two I-frames per second typically using about 4 Mb/s – a big difference from the 180 Mb/s of uncompressed SD video. The set of images between I-frames is a Group of Pictures (GOP) – usually about 12 for 576/50I and 15 for 480/60I transmissions. These are called 'long GOP'. The GOP length can vary during transmission – a new sequence starting with an I-frame may be forced if there is a big change at the input, such as a cut.

M

MPEG-2 12 frame GOP



*Note for transmission the last 'I' frame is played out ahead of the last two 'B' frames to form the sequence I1, B1, B2, P1, B3, B4, P2, B5, B6, P3, I2, B7, B8

Levels and profiles: MPEG-2 is a single compression standard that can operate on many different levels – picture source formats ranging from about VCR quality to full HDTV, and profiles – a collection of compression tools that make up a coding system. Current interest includes the Main Profile @ Main Level (MP@ML) covering current 525/60 and 625/50 broadcast television as well as DVD-video and Main Profile @ High Level (MP@HL) for HDTV. Besides the transmission/delivery applications which use 4:2:0 sampling, the 422 Profile (4:2:2 sampling) was designed for studio use and offers greater chrominance bandwidth which is useful for post production.

Blocking and 'blockiness': MPEG-2 artifacts generally show as momentary rectangular areas of picture with distinct boundaries. Their appearance generally depends on the amount of compression, the quality and nature of the original pictures as well as the quality of the coder. The visible blocks may be 8 x 8 DCT blocks or 'misplaced blocks' – 16 x 16 pixel macroblocks, due to the failure of motion prediction/estimation in an MPEG coder or other motion vector system, e.g. a standards converter.

Audio: Digital audio compression uses auditory masking techniques. MPEG-1 audio specifies mono or two-channel audio which may be Dolby Surround coded at bit rates between 32 kb/s to 384 kb/s. MPEG-2 audio specifies up to 7.1 channels (but 5.1 is more common), rates up to 1 Mb/s and supports variable bit-rate as well as constant bit-rate coding. MPEG-2 handles backward compatibility by encoding a two-channel MPEG-1 stream, then adds the 5.1/7.1 audio as an extension.

See also: Discrete 5.1 Audio, MP3
Websites: www.mpeg.org
www.chiariglione.org/mpeg

MPEG-4

ISO/IEC 14496. MPEG-4 covers three areas, digital television, interactive graphics applications (synthetic content) and interactive multimedia (Web distribution and access to content). It provides the standardized technological elements enabling the integration of the production, distribution and content access of the three fields.

Since its first publication in 1999, MPEG-4 video compression has continued development to achieve quality targets with ever-lower bit rates. Like MPEG-2 the compression is DCT-based and uses inter- and intra-field compression but implements many refinements, such as a choice of block sizes and one-eighth pixel motion compensation accuracy against MPEG-2's half pixel.

MPEG-4 is guilty of generating too many names and versions. The current 'best' MPEG compression technology is known by ISO and IEC as MPEG-4 AVC (Advanced Video Coding). It is also know by the ITU-T as H.264 or MPEG-4 part 10. Notable predecessors are MPEG-4 part 2 (ASP) and H.263. There may yet be more but the rate of compression improvement is now reducing, so it may settle down soon. Most significantly MPEG-4 AVC is reckoned to offer up to a 64 percent reduction in bit rate over MPEG-2 for the same quality. So, for example, this would mean MPEG-2 coded HD video at 16 Mb/s can be delivered with the same quality at only 5.7 Mb/s – opening tremendous possibilities for HD DVDs and transmission, etc., as well as room to offer more SD DTV channels, or more quality. MPEG-4 also specifies low bit rates (5-64 kb/s) for mobile and Internet applications with frame rates up to 15 Hz, and images up to 352 x 288 pixels.

MPEG-4 AVC video coding and decoding are far more complex than MPEG-2 but Moore's Law has already absorbed that. QuickTime and RealPlayer were among early adopters of MPEG-4. While established systems need to stick to their MPEG-2, most if not all new video services are using MPEG-4.

The interactive multimedia side of MPEG-4 includes storage, access and communication as well as viewer interaction and 3D broadcasting. Aural and visual objects (AVOs) represent the content which may be natural – from cameras or microphones, or synthetic – generated by computers. Their composition is described by the Binary Format for Scene description (BIFS) – scene construction information to form composite audiovisual scenes from the AVOs. Hence, a weather forecast could require relatively little data – a fixed background image with a number of cloud, sun, etc, symbols appearing and moving, audio objects to describe the action and a video 'talking head' all composed and choreographed as defined by the BIFS. Viewer interactivity is provided by the selection and movement of objects or the overall point of view – both visually and aurally.

Audio: This builds on previous MPEG standards and includes High Efficiency Advanced Audio Coding (HE-AAC). This nearly doubles the efficiency of MPEG-4 Audio, improving on the original AAC and offers better quality for the same bit rate as the ubiquitous MP3 codec (from MPEG-2). Stereo CD-quality at 48 kb/s and excellent quality at 32 kb/s is reported. This is not a replacement for AAC, but rather a superset which extends the reach of high-quality MPEG-4 audio to much lower bit rates. High Efficiency AAC decoders will decode both types of AAC for backward compatibility.

DVB has approved two MPEG-4 codecs for use for broadcast transport streams: H.264/AVC video codec (MPEG-4 Part 10) and the High Efficiency Advanced Audio Coding (HE-AAC) audio codec. This mandates support of Main Profile for H.264/AVC SDTV receivers, with an option for the use of High Profile. The support of High Profile is mandated for H.264/AVC HDTV receivers.

Websites: www.chiariglione.org/mpeg
www.m4if.org

MPEG-7

The value of information often depends on how easily it can be found, retrieved, accessed, filtered and managed. MPEG-7, formally named 'Multimedia Content Description Interface', provides a rich set of standardized tools to describe multimedia content. Both human users and automatic systems that process audiovisual information are within its scope. It is intended to be the standard for description and search of the vast quantity of audio and visual content that is now becoming available – including that from private databases, broadcast and via the World Wide Web. Applications include database retrieval from digital libraries and other libraries, areas like broadcast channel selection, multimedia editing and multimedia directory services.

MPEG-7 offers a comprehensive set of audiovisual Description Tools (the metadata elements, their structure and relationships that are defined as Descriptors and Description Schemes). It specifies a Description Definition Language (DDL) so that material with associated MPEG-7 data can be indexed and allow fast and efficient searches. These searches will permit not only text-based inquiries, but also for scene, motion and visual content. Material may include stills, graphics, 3D models, audio, speech and video as well as information about how these elements are combined. Besides uses in program-making MPEG-7 could help viewers by enhancing EPGs and program selection.

Website: www.chiariglione.org/mpeg

MPEG-21

Started in June 2001, work on MPEG-21 aims to create descriptions for a multimedia framework to provide a 'big picture' of how the system elements relate to each other and fit together.

The resulting open framework for multimedia delivery and consumption has content creators and content consumers as focal points to give creators and service providers equal opportunities in an MPEG-21 open market. This will also give the consumers access to a large variety of content in an interoperable manner.

Standardization work includes defining items such as Digital Item Declaration (DID), Digital Item Identification and Description (DII&D), Intellectual Property Management and Protection (IPMP).

Website: www.chiariglione.org/mpeg

MPEG-IMX

See IMX

M

MSB

See Digit

MTBF

Mean Time Between Failure. A statistical assessment of the average time taken for a unit to fail – a measure of predicted reliability. The MTBF of a piece of equipment is dependent on the reliability of each of its components. Generally the more components the lower the MTBF, so packing more into one integrated circuit can reduce the component count and increase the reliability. Modern digital components are highly reliable. Even complex electro-mechanical assemblies such as hard disk drives now offer MTBFs of up to a million hours – some 110 years! Note this does not mean a drive has been run for 110 years and failed just once, nor that it is expected to run for this period without failure, but it does indicate the average failure rate of many components of the same type.

MTF
The Modulation Transfer Function is a measure of spatial resolving power. It can refer to a medium, such as film, or a lens, or any part of the scene-to-screen chain. It is akin to frequency response in electronic images. To assess the MTF of film, it is exposed to special test images comprising sine wave bars of successively higher frequencies. The results on the processed film are assessed by measuring its density over microscopically small areas to obtain peak-to-trough values for the different frequencies. These results should then be corrected to allow for the response of the lens, the test film itself and any D/Log E non-linearities.

In a practical film system, the film images pass through many components including the camera lens, intermediate stocks and contact printing to the projection lens. Each of these has its own MTF and the system MTF can be calculated as follows.

MTF_{system} = MTF1 x MTF2 x MTF3 etc…

See also: Resolving power

Multimedia
The presentation of more than one medium. Strictly speaking TV is multimedia (if you have the sound up). More typically it is pictures (moving and still), sound and often text combined in an interactive environment. This implies the use of computers, with the significant amount of data this requires usually supplied either on CD-ROM or via a data link. 'Surfing the net' is an example. High compression ratios are used to allow the use of pictures. One of the first applications was in education; now it is commonly seen at home via the Internet or DVDs.

Multimedia has a wide meaning. Another example is in the production of material which is published in many forms. For example pictures from television productions can be transferred to print for listings magazines, to EPGs and to advertising. Such transfers are commonly handled through networking connections.

See also: ATM, MPEG, MPEG-4, MPEG-21

Multiplex (Mux)
Generally describes a collection of communications channels bundles into one transport system. For example, voice and data co-exist on a phone line carrying conversation and Internet access. In digital television 'a multiplex' describes a group of compressed digital video channels multiplexed into single transmission stream occupying the space of one analog terrestrial TV channel. The term 'Bouquet' has also been used in this context.

MXF

The Material eXchange Format, SMPTE 377M, is aimed at the exchange of program material between file servers, digital video recorders, editing systems, tape streamers and digital archives, etc. It is a container, or wrapper, format that supports a variety of differently coded streams of essence (images and sound), together with metadata describing the material in the MXF file.

There are six operational patterns: Simple, Compiled, Compound, Uncompiled Simple, Uncompiled Compound and Metadata-only. Bridging file and streaming transfers, MXF helps move material between AAF file-based post production and streaming program replay using standard networks. This set up extends the reliable essence and metadata pathways of both formats to reach from content creation to playout. The MXF body carries the content. It can include compressed formats such as MPEG and DV as well as uncompressed video and contains an interleaved sequence of picture frames, each with audio and data essence plus frame-based metadata.

See also: AAF
Website: www.mxf.info

NAS

Network Attached Storage is a file server with an operating system that supports the popular file sharing protocols, such as CIFS (Windows) and NFS (Unix). It is accessed as a client on a network such as Ethernet. This is relatively low cost and easy to set up but it is limited by the constraints of the network. If the network is very busy, then access to the NAS will be slower. An alternative form of shared storage can be set up with a SAN that creates its own separate network.

See also: SAN
Website: www.techweb.com/encyclopedia

NCS

Newsroom Computer System. The name sprang up when the only computer in a TV news area was used for storing and editing the textual information available from news services. It also created the running order for the bulletin and was interfaced to many other devices around the production studio. Today the NCS lives on... but it is no longer the only computer around the newsroom!

See also: MOS

Negative

Film that shows the shot scene as negative images. Various types of negative material are used in several stages of the traditional film production chain that culminates in release prints.

See also: Camera negative, Internegative

Network layer

(1) In TCP/IP, the network layer is responsible for accepting IP (Internet Protocol) datagrams and transmitting them over a specific network.
(2) The third layer of the OSI reference model of data communications.

NFS

Network File System. Developed by Sun Microsystems NFS allows sets of computers to access each other's files as if they were locally stored. NFS has been implemented on many platforms and is considered an industry standard.

See also: IP

Nibble

8 binary bits = 1 Byte
4 binary bits = 1 Nibble; geek humor!

NLE

See Nonlinear (editing)

N

Noise (random)

Irregular level fluctuations of a low order of magnitude. All analog video signals contain random noise. Ideally for digital sampling, the noise level should not occupy more than one LSB of the digital dynamic range. Pure digitally generated signals however do not contain any noise – a fact that can be a problem under certain conditions.

With digital compression, noise has a new importance. Noise, which can originate from analog sources, can be hard to distinguish from real wanted high frequency information. This means compression coders can waste valuable output bandwidth describing the noise to the cost of the real pictures.

See also: Dynamic Rounding

Non-additive mix

A mix of two pictures which is controlled by their luminance levels relative to each other, as well as a mix value K (between 0 and 1): e.g. the position of a switcher lever arm. A and B sources are scaled by factors K and 1-K but the output signal is switched to that which has the greatest instantaneous product of the scaling and the luminance values. The output of any pixel is either signal A or B but not a mix of each. So if K = 0.5, in areas where picture A is brighter than B then only A will be seen. Thus two clips of single subjects shot against a black background can be placed in one picture.

The term has also come to encompass some of the more exotic types of picture mixing available today: for example to describe a mix that could add smoke to a foreground picture – perhaps better termed an additive mix.

See also: Digital mixing

Non drop-frame timecode

Timecode that does not use drop-frame and always identifies 30 frames per second. This way the timecode running time will not exactly match normal time unless it is an exact 30f/s. The mismatch amounts to 1:1000, an 18-frame overrun every 10 minutes. This applies where 59.94, 29,97 or 23.976 picture rates are used in 525/60 systems as well as DTV.

See also: 1000/1001, Drop-frame timecode

Nonlinear (editing)

Nonlinear means not linear – that the recording medium is not tape and editing can be performed in a non-linear sequence – not necessarily the sequence of the program. It describes editing with quick access to source clips and recording space – usually using computer disks to store footage. This removes the spooling and pre-rolls of VTR operations so greatly increasing the speed of work. Yet greater speed and flexibility are possible with realtime random access to any frame (true random access).

See also: FrameMagic, Linear (editing), On-line (editing), True random access

NTFS

New Technology File System – the standard file system of Windows NT and its descendants Windows 2000, Windows XP, Windows Server 2003 and Windows Vista. It replaced Microsoft's FAT file system used in MS-DOS and earlier Windows versions. Advantages include improved metadata support, advanced data structures, reliability, disk space use and extensions such as security access control lists (who can access), permitted operations and file system journaling that logs file changes. Full details are a Microsoft trade secret.

NTSC

The National Television Systems Committee. A U.S. broadcast engineering advisory group.

NTSC (television standard)

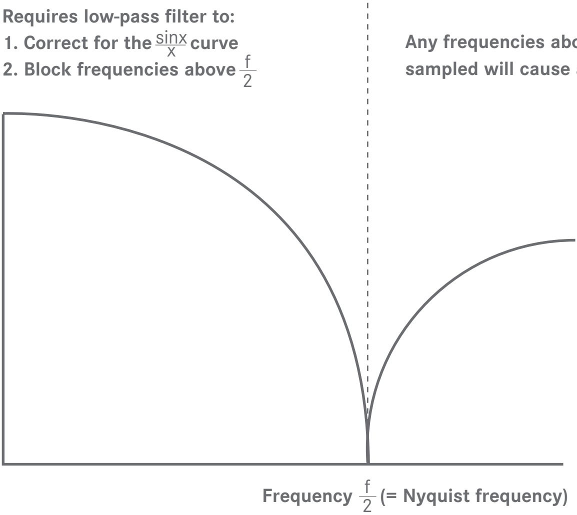
The analog color television system used in the USA, Canada, Mexico, Japan and more, where NTSC M is the broadcast standard (M defining the 525/60 line and field format). It was defined by the NTSC in 1953. NTSC is rapidly becoming part of history, with analog switch-off scheduled to happen in April 2009 in the USA. Note that 'NTSC' is often incorrectly used to describe the 525-line format even when it is in component or digital form.

NVOD

Near Video On Demand – rapid access to program material on demand often achieved by providing the same program on a number of channels with staggered start times. Many of the hundreds of TV channels now on offer will be made up of NVOD services. These are delivered by transmission servers.

Nyquist (frequency)

The minimum frequency that will faithfully sample an analog signal so it can be accurately reconstructed from the digital result. This is always twice the maximum frequency of the signal to be sampled.



In practice significantly higher sampling frequencies are used in order to stay well above the Nyquist frequency, where response drops to zero, and so avoid the chance of producing aliens (unwanted artifacts) and the severe attenuation, according to a Sinx/x characteristic, that exists around the Nyquist point. For example in ITU-R BT.601 the maximum luminance frequency is 5.5 MHz and its sampling frequency is 13.5 MHz.

See also: 13.5 MHz, Into digits (Tutorial 1)

OFDMA

Orthogonal Frequency Division Multiple Access: technology approved by ETSI in 2002 as the core component of DVB-RCT (Return Channel Terrestrial) to create a radio link from viewers' or subscribers' TV equipment back towards the transmitter and is primarily for use in interactive television – for both fixed and mobile applications. As such the bit rate of the return path can be quite low and the transmission power at less than a Watt, while still able to communicate over the considerable distances used by terrestrial systems.

More recently OFDMA is used in the IEEE 802.16-2005 Mobile WiMAX broadband wireless access standard, enabling mobile DSL services and next-generation mobile telephony to provide customers with enhanced voice and data services.

Website: www.runcom.com

Offline (editing)
A decision-making process using low-cost equipment to produce an EDL or a rough cut which can then be conformed or referred to in a high quality online suite – so reducing decision-making time in the more expensive online environment. Most offline suites enable shot selection and the defining of basic transitions such as cuts and dissolves which are carried by EDLs. It is only with the arrival of AAF that there has been an open standard for transporting a much wider range of decisions, including DVE, color corrections, as well as other metadata, between systems from different manufacturers.

See also: AAF

OMFI
Open Media Framework Interchange is an open standard developed by Avid, for post production interchange of digital media among applications and across platforms. It describes a file format and supports video, audio, graphics, animation and effects as well as comprehensive edit decision information. Transfers may be by removable disk or over a high-speed network.

Website: www.avid.com

One light (pass)
A one-light pass refers to a film-processing lab giving the same exposure to a defined length of film, during printing. This is the simplest, quickest and cheapest way to print all the film and the results are typically used for making rushes, dailies, etc. These are often subsequently telecined and recorded to videotape as a reference for the offline decision-making process.

See also: Best light

Online (editing)
Production of the complete, final edit performed at full program quality – the buck stops here! Being higher quality than offline editing, time costs more but the difference has narrowed as the cost of equipment has come down. Preparation in an offline suite will help save time and money in the online. To produce the finished edit, online has to include a wide range of tools, offer flexibility to try ideas and accommodate late changes, and to work fast to maintain the creative flow and to handle pressured situations.

Open Systems Interconnect (OSI)
The OSI Basic Reference Model describes a general structure for communications, defined by the ISO, which comprises seven layers and forms a framework for the coordination of current and future standards – but not defining the standards themselves.

Website: www.iso.ch

OpenEXR

OpenEXR is a file format developed by Industrial Light & Magic for high dynamic range (HDR) images that are used in computer imaging applications. It is used by ILM on motion pictures, has become ILM's main image file format, and is released as free software. It offers a higher dynamic range than 8 or 10-bit pictures, support for 16-bit floating-point, 32-bit floating-point, and 32-bit integer pixels, up to 2:1 lossless compression algorithms, and extensibility to add new compression codecs and image types.

See also: Color Transform Language

Operating system (OS)

The base program that manages a computer and gives control of the functions designed for general purpose usage – not for specific applications. Common examples are MS-DOS, Windows and Linux for PCs, OSX for Apple Macintosh and UNIX. For actual use, for example as a word processor, specific applications software packages are run on top of the operating system. While general purpose operating systems allow a wide range of applications to be used they do not necessarily allow the most efficient or fastest possible use of the hardware for any particular application.

Optical disks

Disks that use optical techniques for recording and replay of material without the read/write heads touching the disk. These offer large storage capacities on 5.25-inch (12 cm) with technologies including CD, DVD, HD DVD, Blu-ray Disc and HVD, offering capacities of 700 MB, 4.7, 15, 25 and 200 GB, with all but CDs offering dual-layer capability or further generations to double the capacity. Single rate data transfer speeds are 1.23, 10, 36/72, 36/72 and 160 Mb/s – even with multiples of speed, data rates are generally still less than for hard drives. They are all available in ROM and read/write forms. Being removable and robust they provide excellent storage for data and digital media.

See also: Blu-ray Disc, DVD, HD DVD, HVD, Professional Disc, XDCAM

Original Camera Negative (OCN)

This is the exposed and developed negative film from the camera. Initially it is the only visual record of a shoot and so is highly valuable. Before digits got involved with film the OCN had to withstand being cut, edited and copied to a make a few master interpositives. Now it can be run just once through a film scanner and then put on the shelf. This reduces the risk of damage and makes a digital copy, that itself can easily be copied for further security.

Orthostereoscopic (Stereoscopic)

A one-to-one condition where what is being displayed is the same as the 'real world'. For example IMAX 3D is often shot with parallel cameras spaced at the average human adult interpupillary distance (approx 63.5 mm) and with wide angle lenses that closely match an audience member's view of the screen.

Over sampling

Sampling information at a higher resolution than is required for the output format. For example, an HD picture can be regarded as an over sampled version of SD. SD pictures created from down res'd HD are generally clearer, cleaner (lower noise) and sharper than those made directly in SD. This is because the size reduction process tends to lower noise and the output pictures are derived from more information than is available in a direct SD scan. An increasing amount of SD material is originated this way. Similarly, 35 mm film provides an over sampled source for SD and HD.

P2

See DV, ING

Pack

A set of clips, mattes and settings for DVE, color corrector, keyer, etc., that are used together to make a video layer in a composited picture. Quantel equipment allows packs to be saved and archived so they can be used later for re-works.

PAL

Phase Alternating Line. The analog color coding system for television widely used in Europe and throughout the world, almost always with the 625 line/50 field system. It was derived from the NTSC system but by reversing the phase of the reference color burst on alternate lines (Phase Alternating Line) is able to correct for hue shifts caused by phase errors in the transmission path.

Bandwidth for the PAL-I system is typically 5.5 MHz luminance, and 1.3 MHz for each of the color difference signals, U and V.

Note that the PAL term is frequently used to describe any 625/50I analog format – even if it is component, or in the 576/50I digital television system where PAL coding is not used.

PAL-M

A version of the PAL standard, but using a 525 line 60-field structure. Used only in parts of South America (e.g. Brazil).

PAN

Personal area network used for communicating between computer-based devices, such as phones, mobile TVs and PDAs as well as fixed computers – all within a few meters – and through to other networks – such as The Internet. PANs can be wired, via busses such as USB or IEEE 1394, or wireless (WPAN) using technologies such as Bluetooth.

Parallel processing

Using several processors simultaneously with the aim of increasing speed over single processor performance. It often refers to array processor computer hardware that carries out multiple, often identical, mathematical computations at the same time. Generally array processors are designed with specific tasks in mind and so are not suitable for running complex operational software. Due to system administration and the fact that not all processors will complete their tasks at the same moment, causing waiting time, the increase in speed gained by sharing the task is not likely to be proportional to the number of channels available.

Due to the very different structure of a parallel processing computer, software designed to run on a single processor system may well need major changes to take full advantage of a parallel system. The current expansion of popular PC CPUs to offer two or four processors generally works with established applications by running the various applications on separate core processors, rather than one application on multiple processors.

Parallax (Stereoscopic)

This refers to the separation of the left and right images on the projection device or display screen. Positive Parallax puts an object behind the screen (on screen objects in the left eye image are to the left of the same objects in the right eye image). Negative parallax puts an object in front of the screen (on screen objects in the left eye image are to the right of the same objects in the right eye image).

Zero or neutral parallax puts an object on the screen (on screen objects in the left eye image are overlaid on the same objects in the right eye image).

The only difference between stereo cameras should be parallax or angle between the axes of the lenses, as in Camera Convergence – anything else can disturb the stereo viewing experience. This requires close attention, so that the cameras are set-up the same and with the same filters. Color differences, skewing, vertical misalignment, differential weave and hop, lens flares, poor VFX fixes, scratches and dirt can all cause problems.

Fast cuts between shots with strong positive and strong negative parallax can be unsettling in some circumstances. This is because the eyes and brain are being asked to jump uncomfortably quickly between positions and then make sense of the result. This can be mitigated by the use of 'handing off' – dynamically changing the convergence of an outgoing shot in relation to an incoming shot. Another method of dealing with this is trying wherever possible to cut between shots that are somewhat close in parallax.

Vertical parallax is a vertical offset between stereo images and is very uncomfortable to watch – so it is necessary to remove it during post production if there has been camera misalignment during shooting.

Note: The term 'Parallax' is sometimes used interchangeably with 'Congruence' or 'Disparity'

Perf

Short for perforations. It is a way to describe some information about the format of images on 35mm film by how many of the perforations, or sprocket holes, are used per image. For example, Full Frame is 4 perf.

P-frames

See MPEG-2

Photo-real

Video and film effects that are constructed in such a way that they look totally real and not synthetic are referred to as photo-real effects. This use of effects has increased rapidly and has changed the way many productions are shot and post produced – leading to lower budgets and better looking results.

Achieving photo-real results requires careful planning from the shoot and computer imagery through to compositing in post production. Excellence in keying, so there are no telltales of blue screen haloes or color spill, are among the many techniques required for successful results.

See also: Compositing, Digital keying

P

Pixel (or Pel)

A shortened version of 'Picture cell' or 'Picture element'. The name given to one sample of picture information. Pixel can refer to an individual sample of R, G, B, luminance or chrominance, or sometimes to a collection of such samples if they are co-sited and together produce one picture element.

See also: Aspect ratio – of pixels, Sub-pixel

PLD

Programmable Logic Device. This is a family of devices that has included PROMs (Programmable Read Only Memories), PLAs (Programmable Logic Arrays) and PALs (Programmable Array Logic). Today FPGAs (Field Programmable Gate Arrays) are the main interest. These range in size and complexity from a few dozen up to millions of gates to provide a compact and efficient means of implementing complex non-standard logic functions. They are widely used in Quantel equipment where FPGAs also offer a fast track for the implementation of new improvements and ideas.

See also: Moore's Law

Plug-in

Software, usually from a third party, that brings added functionality to a computer application. For post production this may add highly specialized aspects to digital effects.

POTS

Plain Old Telephone Service. This is the analog connection that many people still speak on, or connect their modems or fax machines to. Its applications have gone far beyond its initial aims.

Printer lights

The illumination used to expose film in a processing laboratory. 'White' light is passed through red, blue and green filters so that the exposure to each can be individually controlled. Film is contact printed, placing the new film stock against the processed film that carries the images. The amount of light can be varied to provide the required exposure to show more detail in the highlights or the shadows or to keep to the mid-range of the scene brightness. To print an overexposed negative will require higher values and underexposed lower values of printer lights. A change of 1 in the value represents 1/12th of a stop adjustment in exposure. Differential adjustments of the values provides basic color correction (timing). The values for the lights are recorded as grading (timing) numbers onto disk or paper tape.

See also: Color timing, Film Basics (Tutorial 2), One-light pass, Timing

Print film

Film stock designed specifically for distribution and exhibition at cinemas. Unlike negative film, it is high contrast and low on latitude. This is designed to give the best performance when viewed at cinemas. Obviously a release print has to be clear of the orange base so this is bleached out during processing.

See also: Film basics (Tutorial 2)

Profile

See MPEG-2

Professional Disc (PD)

Sony's name for their Blue Laser disk technology used in XDCAM products and for data recording. This has many similarities to the Blu-ray disk, with CD/DVD dimensions it is housed in a cartridge, weighs 90g and offers 23.3 GB storage on one-side and a data rate of 9 MB/s (72 Mb/s). It can support 70 minutes of 50 Mb/s MPEG IMX and faster-than-realtime transfers. Good for around 10,000 re-record cycles it is more compact, faster and more versatile than tape.

Continued development is predicted to produce a second-generation model with 50 GB per side and transfers up to 18 MB/s and onward to a third generation doubling those figures again.

See also: Optical disks

P

Progressive (scan)

Method of scanning lines down a screen where all the lines of a picture are displayed in one continuous vertical scan (progression). There are no fields or half pictures as with interlace scans. Progressive scanning is becoming far more common as it is used with computer displays and all panel displays – LCD and Plasmas, and is now starting to be used for some DTV formats, e.g. – 1080/24P, 720/60P. The 'P' denotes progressive.

A high picture refresh rate is required to give good movement portrayal, such as for fast action and camera pans. For television applications using progressive scanning, this implies a high bandwidth or data rate and high scanning rates on CRT displays. Progressive scanning does not show the dither of detail associated with interlaced scans.

There are now 50 and 60 Hz progressive 1080-line standards. These 'super' HD formats are gaining ground and new infrastructure with up to 3 Gb/s capability is being installed to accommodate it in production… but this is not a transmission standard yet!

See also: 24P, Interlace, Interlace Factor

Projectors (digital)

Digital projectors input digital images and project them onto cinema-sized screens. Huge advances in this technology in recent years have been one of the driving forces behind digital cinema. For post production or DI, many houses offer big screens for customers to see what the final cinema experience will look like.

Among the prominent projection technologies in the large projector area are D-ILA from JVC, SXRD from Sony and DLP from Texas Instruments. These projectors work by shining the projector light at reflective chips that display the image, so modulating the light that is reflected towards the projector's lens. With resolutions up to 4K, the viewing public is very impressed with the results as, without film's scratches, dirt and weave, they are treated to consistent high quality results. Combined with suitable digital cinema players some projectors can sequentially display the left and right-eye images of stereo movies for a 3D film experience.

See also: Color management, Digital Cinema, DLP, D-ILA, SXRD

Pseudoscopic (Stereoscopic)

If a stereoscopic signal is reversed (e.g. each eye is being fed the opposite eye signal) a strange 'punched in' effect appears. This is also referred to as inverted stereo or reversed stereo.

Publishing

See Deliverables

Pulfrich effect (Stereoscopic)

Horizontal motion that can be interpreted as binocular depth. A stereo effect which is produced when 2D images moving laterally on a single plane are viewed at slightly different times by each eye.

Purpose-built hardware

Hardware and software built for a specific task (e.g. a DVE), not general purpose (computer). Purpose-built hardware is able to provide much improved processing speeds, between 10 and 100 fold, over systems using the same technology applied to general-purpose architecture and operating system software. This becomes important in image processing where tasks require a great deal of power, especially as the demands increase in proportion to the picture size – significant for working with HDTV and digital film.

However, as standard/general-purpose platforms continue to become ever more powerful, so it can make sense to swap out some purpose-built hardware, which tends to be more costly, for software solutions. This ability to swap is a part of Quantel's generationQ architecture. Another approach is to use some new specialist GPUs to provide accelerated image processing.

Quantel

Apt name for the world leaders in digital television equipment – abbreviated from QUANtized TELevision. Quantel has 35 years' experience of digital television techniques – significantly more than any other manufacturer.

Quantization

Factor applied to DCT coefficients as a part of the process of achieving a required video compression. The coefficients relating to the least noticeable aspects of picture detail – e.g. high frequencies with low amplitude – are progressively reduced so that the final data will fit into the specified data file space. This space is often fixed and relates directly to the quoted compression ratio for I-frame only schemes such as DV. Note that the required quantization will vary according to scene content. Given that too much data would cause problems by overflowing the allotted capacity of the file, compression schemes are cautious and designed to undershoot the file limit. To what extent the files are filled is a measure of the quality of a compression scheme – a reason why the quoted 'compression ratio' does not tell the whole story.

Quantizing

The process of sampling an analog waveform to provide packets of digital information to represent the original analog signal.

See also: Into digits (Tutorial 1)

QuickTime

QuickTime is a multimedia framework developed by Apple Inc. capable of handling various formats of digital video, media clips, sound, text, animation, music, and several types of interactive panoramic images. Running on either OSX or Windows operating systems, QuickTime supports software packages including iTunes, QuickTime Player and Safari.

RAID

Redundant Array of Independent Disks. A grouping of standard disk drives together with a RAID controller to create storage that acts as one disk to provide performance beyond that available from individual drives. Primarily designed for operation with computers, RAIDs can offer very high capacities, fast data transfer rates and much increased reliability of data. The latter is achieved through disk redundancy so that disk errors or failures can be detected and corrected.

A series of RAID configurations is defined by levels and, being designed by computer people, they start counting from zero. Different levels are suited to different applications.

RAID levels

Level 0
No redundancy – benefits only of speed and capacity – generated by combining a number of disks.

Level 1
Complete mirror system – two sets of disks both reading and writing the same data. This has the benefits of level 0 plus the security of full redundancy – but at twice the cost. Some performance advantage can be gained in read because only one copy need be read, so two reads can be occurring simultaneously.

Level 2
An array of nine disks. Each byte is recorded with one bit on each of eight disks and a parity bit recorded to the ninth. This level is rarely, if ever, used.

R

Level 3
An array of n+1 disks recording 512 byte sectors on each of the n disks to create n x 512 'super sectors' + 1 x 512 parity sector on the additional disk which is used to check the data.

The minimum unit of transfer is a whole superblock. This is most suitable for systems in which large amounts of sequential data are transferred – such as for audio and video. For these it is the most efficient RAID level since it is never necessary to read/modify/write the parity block. It is less suitable for database types of access in which small amounts of data need to be transferred at random.

Level 4
As level 3 but individual blocks can be transferred. When data is written it is necessary to read the old data and parity blocks before writing the new data as well as the updated parity block, which reduces performance.

Level 5
As level 4, but the role of the parity disk is rotated for each block. In level 4 the parity disk receives excessive load for writes and no load for reads. In level 5 the load is balanced across the disks.

Soft RAID
A RAID system implemented by low level software in the host system instead of a dedicated RAID controller. While saving on hardware, operation consumes some of the host's power.

RAM

Random access memory – cost-effective memory chips (integrated circuits) used extensively in computers to give fast access (compared to disks, tapes etc. – RAM has no moving parts) and very high data rates. RAM is available in several different forms and has been subjected to Moore's Law for over three decades. When RAM chips first arrived they had a huge impact and, as they have grown in capacity and speed while unit price remains reasonably stable, their applications and importance have multiplied.

DRAM – Dynamic RAM. DRAM chips provide high density memories which must be powered and clocked to retain data. Synchronous DRAM (SDRAM) is faster, running up to 200 MHz clock rate. DDR SDRAM is Double Data Rate (DDR) SDRAM and is increasing the performance of many of the newer PC and graphics products. Current available capacities are up to 2 Gb per chip. Their fast access rate has allowed DRAM to replace more expensive SRAM in some applications. DDR 2 increases the data rate and DDR 3 reduces the higher power consumption of DDR 2. There are many more variations and versions to suit specific applications. Development continues.

SRAM – Static RAM memory chips in general behave like dynamic RAM (DRAM) except that static RAMs retain data in a six-transistor cell needing only power to operate (DRAMs require clocks as well). Because of this, current available capacity is lower than DRAM – and costs are higher, but speed is also greater.

See also: Flash Memory

Raw data (a.k.a. source data)

Data that has not been processed for use. Digital cinematography cameras can generally output raw data of images that includes the full brightness range it can extract from a scene, and a signal that has not been processed for color or to suit any target viewing conditions – such as cinema or gamma corrected for home TV viewing.

Resolution

A measure of the finest detail that can be seen, or resolved, in a reproduced image. Whilst it is influenced by the number of pixels in the display (e.g. high definition 1920 x 1080, broadcast SDTV 720 x 576 or 720 x 487) note that the pixel numbers do not define the resolution but merely the resolution of that part of the equipment chain. The quality of lenses, picture displays, film processes, edit systems and film scanners, etc., in fact any element in the program stream (from scene to screen), must be taken into account in assessing overall system resolution.

See also: Concatenation, MTF

Resolution co-existence

Term coined by Quantel to describe equipment able to operate with several moving image formats at the same time. For example, an editing system able to store and operate with any DTV production format material, making transitions between shots, composing layers originating from more than one format (resolution) and outputting in any chosen format. Good equipment will be designed for fast operation at the largest specified TV format, e.g. 1920 x 1080 HD, and so may operate faster with smaller images, but also may be able to handle larger images.

See also: Resolution independent

Resolution independent

A term used to describe the notion of equipment that can operate at more than one resolution, though not necessarily at the same time. Historically, most dedicated television equipment was designed to operate at a single resolution although some equipment, especially that using the ITU-R BT.601 standard, could switch between the specific formats and aspect ratios of 525/60 and 625/50. More recently, the advent of the multiple formats of HDTV has encouraged new equipment able to operate with many, or all, of the video standards.

In today's converged media world the gamut of digital 'video' formats now includes motion picture formats up to 4K and mobile TV operating in many formats down to 320x240, or 176x144 on phones.

By their nature computers can handle files of almost any size so, when used for images, they can be termed 'resolution independent'. However, as larger images require more processing, more storage and more bandwidth so, for a given platform, the speed of operation will slow as the resolution increases.

Other considerations when changing between video image resolutions may include the need to reformat or partition disks, check for sufficient RAM, allow extra time for RAM/disk caching and to select an appropriate display.

See also: Resolution co-existence

Resolving power

The resolving power of an imaging medium is a measure of its maximum spatial resolution. For digital media the pixel count dictates the maximum possible resolving power. For film it is assessed by exposing it to special test images comprising sine wave bars of successively higher frequencies. The results on the processed film are then judged by a panel of viewers – making them somewhat subjective.

See also: MTF

Restoration

Hiding or removing the defects acquired by old (archive) material and content. Digital technology has enabled many new and easy-to-use procedures to provide fast and affordable restoration. These range from fully automated systems – that depend on recognizing generic faults and treating them – to hands-on operations that offer access to appropriate toolsets – often presented as 'brushes'.

These have been applied to both television and to film, and succeeded in making available many old archives for the ever-hungry TV channels.

Return control (path)

Return control is needed for interactive television. It needs only to offer quite a low data rate but have little latency, as action should be followed as soon as possible by reaction. DVB includes methods for return paths for cable, DVB-RCC; satellite-RCS; and terrestrial–RCT, services. While cable and terrestrial are devised to operate economically for individual viewers, the satellite solution is more appropriate for head-ends or groups – due to cost. Interestingly DVB-RCS has been adopted by many companies operating in the general telecoms world.

See also: WiMax

RGB

The abbreviation for the Red, Green and Blue signals, the primary colors of television. Cameras and telecines have red, green and blue receptors, the TV screen has red, green and blue phosphors or LEDs. RGB is digitized with 4:4:4 sampling which generates 50% more data than 4:2:2.

Rotoscoping

The practice of using frames of live footage as reference for painting animated sequences. Today, the meaning has extended to cover a whole range of manual retouching techniques. While the painting will always be down to the skill of the artist, modern graphics equipment integrated with a video disk or RAM store makes rotoscoping, or any graphical treatment of video frames, quick and easy. This has led to many new designs and looks appearing on television as well as more mundane practices such as image repair.

RS 232

A standard for serial data communications defined by EIA standard RS-232 that is designed for short distances only – up to 10 meters. It uses single-ended signaling with a conductor per channel plus a common ground, which is relatively cheap, easy to arrange but susceptible to interference – hence the distance limitation.

RS 422

Not to be confused with 4:2:2 sampling or 422P MPEG, this is a standard for serial data communications defined by EIA standard RS-422. It uses current-loop, balanced signaling with a twisted pair of conductors per channel, two pairs for bi-directional operation. It is more costly than RS232 but has a high level of immunity to interference and can operate over reasonably long distances – up to 300m/1000 ft. RS 422 is widely used for control links around production and post areas for a range of equipment – VTRs, mixers, etc.

RSN

Real Soon Now. A phrase coined by Jerry Pournelle to satirize the tendency in the computer industry to discuss (and even offer for sale) things that are not actually available yet.

Run-length coding

A system for compressing data. The principle is to store a pixel value along with a message detailing the number of adjacent pixels with that same value. This gives a very efficient way of storing large areas of flat color and text but is not so efficient with pictures from a camera, where the random nature of the information, including noise, may actually mean that more data is produced than was needed for the original picture.

Safe area

The area of picture into which it is considered safe to place material, graphics, text or action, so that it will be viewable when received at home. Initially this was necessary with 4:3 aspect ratio screens as they were always overscanned to avoid showing the black that surrounds the active picture. Typically 5% in from the edges was considered safe. More recently the whole Safe Area issue has become far more complicated as there are both 4:3 and 16:9 displays, as well as 4:3, 16:9 and sometimes 14:9 (a compromised version of 16:9 that is more acceptable to those viewing on, generally analog, 4:3 screens) aspect ratios for program output. The transition to HD, always 16:9, ensures safe areas will need careful attention for many years yet. In the UK action has been taken to make all commercials able to convey their message whichever display aspect is used. The EBU website referenced below provides a very practical reference document as a download.

See also: Aspect ratio (of pictures)
Website: document R95-2000 at (www.ebu.ch) – best found by Internet search engine

SAIT-2

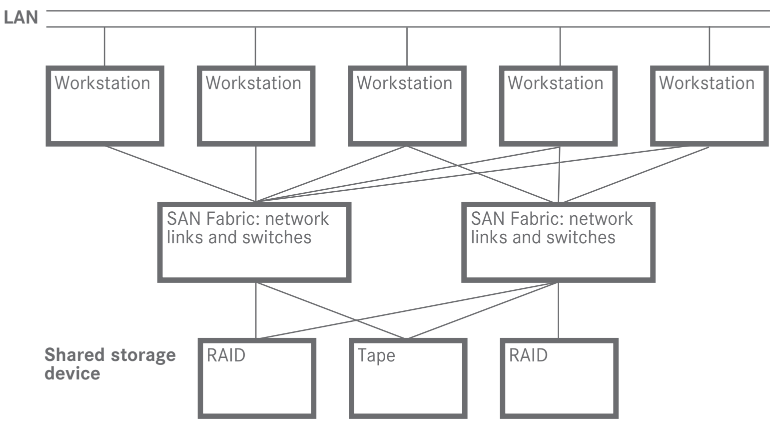
Super Advanced Intelligent Tape format that uses a 12.7mm (half-inch) wide tape and a helical scan format. It is designed for the general data storage market and is also used for the archive and transfer of file-based media data. SAIT-2 tape has a native capacity of 1 TB and a transfer rate of 60 MB/s, offering lossless compressed storage of 2.6 TB and transfer of 144 MB/s. There is a roadmap for SAIT-3 and SAIT-4 that speculatively predicts doubling of performance for each generation, projected for completion by 2010.

Sampling standard

A standard for sampling analog waveforms to convert them into digital data. The official sampling standard for 625/50 and 525/60 television is ITU-R BT.601. ITU-R BT.709 and SMPTE 274M specify sampling for HD formats. They are generally written as the number of pixels per line x number of lines per frame/vertical refresh rate (in Hz) progressive or interlaced (P or I). For example: 1920 x 1080/50I. Sometimes the pixel count of the lines is omitted (but understood), making the example 1080/50I.

SAN

Storage Area Networks are a well-established method of providing shared video storage and can offer platform-independent storage that may be accessed from, say, both Windows and Linux workstations. They allow applications direct access to shared storage by cutting out the usual client-server 'middle men' to provide improved workflow and better work sharing on a common store.



The design recognizes that moving large amounts of data (video) is inconsistent with normal-network general-data traffic. Therefore they form a separate network to connect data-hungry workstations to a large, fast array of disks. Although any network technology could be used, Fibre Channel predominates. Its original 800Mb/s thoughput (1 Gb/s line rate) data rate has now grown to 8Gb/s and direct connections to disks are ideal for making large, fast storage networks. SANs are scalable but additions may be complex to implement. Currently, expansion is ultimately limited by architecture and management considerations.

S

However, in practice it can be difficult to sustain multiple high bandwidth (e.g. 2K or 4K) streams from a SAN. Quantel's Genetic Engineering is a recent development designed to solve this problem and is capable of playing back multiple 2K and 4K streams simultaneously.

See also: FAN, Fibre Channel, NAS
Website: www.snia.org
www.techweb.com/encyclopedia/defineterm?term=SAN

SATA
Serial ATA (Advanced Technology Attachment) is designed to transfer data between disks drives (hard and optical) and computer hardware and is the successor of ATA. SATA adapters and devices communicate over a high-speed serial link originally specified in SATA I at 1.5 Gb/s, now SATA II at 3 Gb/s and SATA III at 6 Gb/s is planned. The serial interface means the connector is smaller (than ATA) and can run faster – as fast parallel data starts to suffer from skewing – serial does not. SATA does not just serialize ATA. SATA II adds native command queuing, originally a feature of SCSI, that allows handling multiple pending transactions rather than just one at a time. This allows the disk to organize the transactions for faster operation.

Website: www.sata-io.org

Scaling
Analog video signals have to be scaled prior to digitizing in an ADC so that the full amplitude of the signal makes best use of the available levels, or numbers, in the digital system. The ITU-R BT.601 digital coding standard specifies, when using 10 bits, black to be set at level 64 and white at 940. The same range of values is ascribed should RGB be used. Computer applications tend to operate with a different scaling with black set to level 0 and white at 1023. For color they usually use RGB from 0-1023. However, most still keep to 8-bit accuracy so the scale runs from 0-255. Clearly, going between computers and TV requires processing to change color space and scaling.

See also: Into digits (Tutorial 1)

Schema
A collection of tables and constraints that describe the structure of a database. It provides a level of security as no one else can interpret the stored database without the schema; it is just a collection of figures. It organizes the database to allow scalability for expansion and defines efficient operation to suit a particular application.

Scrub (audio)
Replay of audio tracks at a speed and pitch corresponding to jog speed – as heard with analog audio tape 'scrubbing' backwards and forwards past an audio replay head. This feature, which is natural for analog fixed-head recorders, may be provided on a digital system recording on disks to help set up cues.

SCSI

The Small Computer Systems Interface is a high data rate, general-purpose parallel interface introduced in 1979 allowing up to eight devices to be connected to one bus (now 16 for Wide SCSI). This could comprise a controller and up to seven disks or devices of different sorts – hard disks, optical disks, tape drives, scanners, etc., and may be shared between several computers.

Since then SCSI has hugely increased in performance but is now used mainly on high-performance workstations and RAIDs on servers while other lower cost interfaces such as USB2 and IEEE1394 connect external devices and SATA is used for hard disks.

The original SCSI specified a cabling standard (50-way) that had to be kept short, a protocol for sending and receiving commands and their format. It is intended as a device-independent interface so the host computer needs no details about the peripherals it controls. SCSI's continued development has resulted in the following range of maximum transfer rates that keep ahead of modern disk drive transfer rates:

Standard SCSI	5 M transfers/sec. (max)
Fast SCSI	10 M transfers/sec. (max)
Ultra SCSI	20 M transfers/sec. (max)
Ultra SCSI 2 (LVD)	40 M transfers/sec. (max)
SCSI 80	80 M transfers/sec. (max)
SCSI 160	160 M transfers/sec. (max)

There are other SCSI interfaces. Fibre Channel (FC) can be used as the transport medium with FC-AL 1Gb to FC-AL 4Gb offering data throughputs of up to 100 – 400 MB/s over distances of 3km. Longer term, it is believed that iSCSI, Ultra 3 SCSI over TCP/IP, will win out as developments in Ethernet outpace those in FC. The performance of this though is network-dependent.

Serial SCSI using SSA (Serial Storage Architecture) FC-AL, IEEE1394, and Serial Attached SCSI (SAS), break away from the parallel cabling to offer data transfers up to 300 MB/s (over SAS). This is an area of further development.

See also: Disk drives

SD, SDHC

See SDTV, Secure Data

SDI

See Serial Digital Interface

SDK

Software Developers Kit. Typically a software and documentation package to facilitate the development of applications to run on a given operating system or other application. It provides another layer on top of an API, often including shortcuts and pre-built routines to make development easier and final operation faster.

SDTI

Serial Digital Transport Interface (SMPTE 305M). Based on SDI, this provides realtime streaming transfers. It does not define the format of the signals carried but brings the possibility to create a number of packetized data formats for broadcast use. There are direct mappings for SDTI to carry Sony SX, HDCAM, DV-DIFF (DVCAM, DVCPRO 25/50, Digital-S) and MPEG TS.

SDTV

Standard Definition Television. Digital television systems that operate using standard definition video formats, i.e. 720 x 460/60I or 720 x 567/50I. In both these may carry 4:3 or 16:9 images, and in all cases, the pixels are not square. All HDTV digital standards describe square pixels.

Secondary color correction

Primary color correction, or grading, is applied to the whole image. Secondary correction is applied only to selected areas of the image – the area being defined by a pattern generator (e.g. a circle or rectangle), by curved lines or derived from the object itself using chromakey techniques – or any combination of all these. This way, for example, the color of a car in a clip could be changed from say, red to green.

Secure Data

A non-volatile memory card format that is widely used in portable devices, including digital cameras, handheld computers, PDAs, GPSs. For television Panasonic offers its P2 professional camcorders with PC cards each containing four SD chips.

The SD cards are specified with speeds described as multiples of the standard CD data speed – 150 kB/s, and capacity. The latest cards, from 2 GB up, are SDHC (high capacity) and capacity currently up to 32 GB, but this is changing fast. Minimum writing speed is shown as Class 2, 4 or 6 offering 2, 4 or 6 MB/s. As development of these devices continues so the applications widen. Card assemblies are available offering drop-in replacements for hard disk drives, currently up to 64 GB of SD storage – and rising.

See also: Flash memory, ING, P2, RAM
Website: www.sdcard.org

SED

Surface-conduction Electron-emitter Display technology is a mix of old and new, coupling Cathode Ray Tube (CRT) and LCD technologies. SED screens comprise thousands, even millions, of minute electron emitters – hence the CRT connection. The screens are thinner LCD displays and observers think SED technology is superior to current LCD and plasma monitors. Deliveries are slated to start in 2008 but may be delayed, and will concentrate on the bigger-screen end of the market – around 55-inches, initially.

Seek time (a.k.a. Positioning time)

The time taken for the read/write heads of a disk drive to be positioned over a required track. Average seek time is the time to reach any track from the center track. Maximum seek/positioning time is the time to reach any track from any track. A high performance modern hard disk offers around 4 ms average seek time and typically twice that for the maximum. Minimum seek time to adjacent tracks is as low as 0.2 ms for read, 0.4 ms for write. These times are critical to disk performance, especially when operating with the very high data rates associated with video and digital film.

See: Disk drives, FrameMagic

Serial Digital Interface (SDI)

Serial Digital Interface carries uncompressed digital video, multiple tracks of embedded audio and ancillary data over the ubiquitous 75-ohm coax cable, terminated in a BNC connector. As the demands of television have grown so has SDI. Today there are three types.

SDI SMPTE 259M – for SD 4:2:2 digital television, is based on a 270 Mb/s transfer rate. This is a 10-bit, scrambled, polarity-independent interface, with common scrambling for both component ITU-R BT.601 and composite digital video and four groups each of four channels of embedded digital audio. Most broadcast digital equipment includes SDI which greatly simplifies its installation and signal distribution. It can transmit the signal over 200 meters (depending on cable type).

HD-SDI Standardized in SMPTE 292M, this for 4:2:2 HD television. The serial bit-stream runs at 1.485 Gb/s to carry up to 10-bit Y,Cr,Cb component video as well as embedded audio and ancillary data. The interface is also specified for fiber for distances up to 2 km.

3G SDI (SMPTE 424M) operates at 2.97 Gb/s, twice the clock rate HD-SDI and is designed to carry high bandwidth HD television such as 1080/50P, 1080/60P, HD RGB, as well as 2K DI images.

See also: Dual link, HSDL, Embedded audio

Server editing

Video and audio editing that takes place within a server rather than in a workstation.

See also: In-server editing

Server (file)

A storage system that provides data files to all connected users of a local network. Typically the file server is a computer with large disk storage which is able to record or send files as requested by the other connected (client) computers – the file server often appearing as another disk on their systems.

The data files are typically around a few kB in size and are expected to be delivered within moments of request.

Server (video)

A storage system that provides audio and video storage for a network of clients. Those used in professional and broadcast applications are based on hard disk storage.

Aside from those used for video on demand (VOD), video servers are applied in three areas of television operation: transmission, post production and news. Compared to general-purpose file servers, video servers must handle far more data, files are larger and must be continuously delivered.

There is no general specification for video servers and so the performance between models varies greatly according to storage capacity, number of realtime video channels, protection level (RAID), compression codec and ratio, and speed of access to stored material – the latter having a profound influence.

Store sizes are very large, typically from about 500 GB up to a few terabytes. Operation depends on connected devices: edit suites, automation systems, secondary servers, etc. The effectiveness of the server's remote control and video networking is vital to success.

Shannon Limit

In 1948, C. E. Shannon's article 'The Mathematical Theory of Communication,' established Information Theory which allows determination of the theoretical limit of any channel's information-carrying capacity. Information Theory made possible development of digital systems and without it, much of modern communications, including the Internet, would not exist. Only very recent technology has allowed operation close to the Shannon limit – V.34 33.6 kb/s phone modems are an example.

Signal-to-noise ratio (S/N or SNR)

The ratio of noise to the wanted picture/signal information – usually expressed in dB. Noise can be high frequency – making pictures look grainy or adding hiss to sound. Digitally generated images or sounds are theoretically capable of being pure – noise-free – having an infinite signal to noise ratio. But for pictures, their purity may cause contouring artifacts if processed without special attention – a reason for Dynamic Rounding.

A rule of thumb to express the realistic signal to noise capability of a digital system is given by the expression:

S/N (dB) = 6N + 6

where N is the number of bits. Hence an 8-bit system gives 54 dB S/N and a 10-bit system 66 dB. This would be the noise level of continuous LSB dither and would only be produced over the whole picture by digitizing a flat field (i.e. equal gray over the whole picture) set at a level to lie midway between two LSBs. If it were set exactly on a digital level, there would be no noise. Other test methods give a variety of results, mostly producing higher S/N figures.

See also: Contouring, Decibel, Dither, Dynamic Rounding, MPEG-2

Simulcasting
The term used to describe the simultaneous transmission of a program over more than one channel: for example one analog PAL and another digital HD. Both versions are transmitted frame accurately at the same time to ensure that no viewer is disadvantaged.

Simultaneous true random access
Describes access on a video server where each of its realtime video connections can access any sequence of stored frames regardless of the demands of other video connections. This implies there is no copying of material to achieve this. Such access makes control of video servers much more straightforward, and allows many independent operations to take place at the same time.

See also: FrameMagic, True random access

S

SMPTE
Society of Motion Picture and Television Engineers. A United States organization, with international branches, which includes representatives of broadcasters, manufacturers and individuals working in the film and television industry. It has within its structure a number of committees that make recommendations (RP 125 for example) to the ITU-R and to ANSI in the USA.

Here are just a few of the many standards and recommendations issued by SMPTE

259M	SDI for 4:2:2 and $3f_{sc}$
272M	AES/EBU audio and aux data into Video a ancillary space
292M	HD-SDI
294M	TV format, 720 x 483 at 59.94P Hz
305M	SDTI Serial Data Transport Interface
424M	3 Gb/s signal/data serial interface

See: Directory
Website: www.smpte.org

SNMP

Simple Network Management Protocol is the Internet standard protocol developed to manage nodes (servers, workstations, routers, switches, hubs, etc.) on IP networks. It enables network administrators to manage network performance, find and solve network problems, and plan for network growth. SNMP works by sending Protocol Data Units (PDUs) messages to different parts of a network. Agents, SNMP-compliant devices, store data about themselves in Management Information Bases (MIBs) and return this data to the SNMP requesters.

Square pixels

See Aspect ratio – of pixels

SRAM

See RAM

SSD

See Flash Memory

Standard platform

A computer and operating system built for general-purpose use. It cannot be used on its own but must be fitted with any, or many, of the very wide range of specific application software and additional hardware packages available. For example, the same standard platform may be used for accounting, word processing and graphics but each runs from a different software applications package and may need special hardware.

The term has become somewhat confusing in that a standard platform can be anything from a PC to a super computer. Also some applications are mutually exclusive – when the computer's hardware is configured for one it has to be re-configured to run another. It is then arguable whether this is still a standard platform or has it metamorphosed into a dedicated system?

Standards (television)

A digital television standard defines the picture format (pixels per line and active lines), vertical refresh rate and whether the vertical scan is interlaced or progressive. For example, European SD digital television is 720 x 576/50I, and an HD standard is 1920 x 1080/30P.

See also: Format (television)

Standards conversion

Changing the standard of existing television material that may involve two processes (four if going from and to analog coded systems such as PAL and NTSC). The two main processes are format conversion to change the spatial (horizontal and vertical) sizes of the pictures and changing the vertical scan rate – the number of pictures per second. For broadcast applications this needs to be completed retaining the maximum possible fidelity of the input content. The re-sizing process involves the relatively straightforward task of spatial interpolation – spreading the information from the original pixel array over a different pixel structure. Note that the crude method of dropping or repeating lines/pixels will give very poor results and the detail of the interpolation process used is important for best results.

The second process is more complex as, changing the number of frames or fields per second (temporal conversion) means creating new ones or removing some – preferably without upsetting any movement shown in the pictures, so simply repeating or dropping fields or frames will not do. For this the movement within the pictures has to be analyzed so that 'in-between' pictures can be synthesized. This is a very specialized area and there are highly developed techniques used on the best modern standards converters that do this very well, but never perfectly.

See also: Format (conversion), Frame-rate conversion

Statistical multiplexing (a.k.a. Stat Mux)

This increases the overall efficiency of a multi-channel digital television transmission multiplex by varying the bit-rate of each of its channels to take only that share of the total multiplex bit-rate it needs at any one time. The share apportioned to each channel is predicted statistically with reference to its current and recent-past demands. For example, football – generally with much action and detail (grass and crowds) – would use a higher data rate than a chat show with close-ups and far less movement. The data streams for each program are monitored and their bit rates varied accordingly to fit the bit rate of the whole multiplex.

See also: Variable bit rate

Status M and Status A

See: Densitometer

StEM

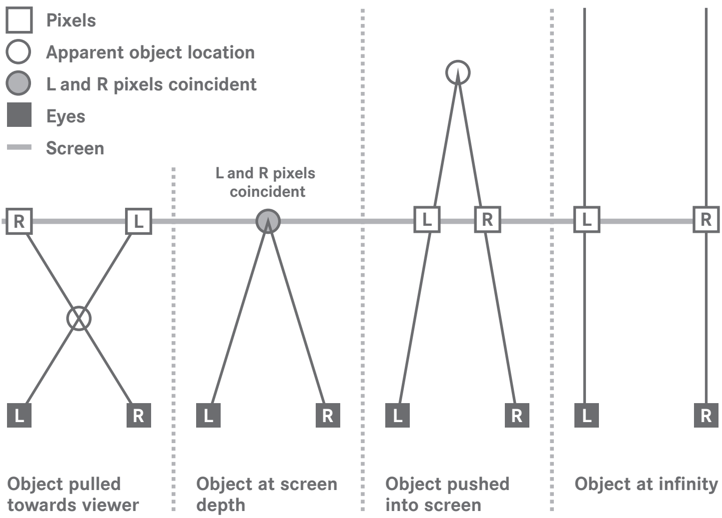
Standard Evaluation Material was created by the ASC (American Society of Cinematographers) and DCI in 2004 to assess the quality of possible digital cinema compression systems and formats against the best that film can offer. It is about 25 minutes of material from multiple film formats. At the time the major compression system used for video was MPEG-2 and some said the StEM film was an MPEG-breaker with smoky scenes and movement that would challenge that compression system. The next year DCI recommended JPEG 2000, an entirely different compression system.

Stencil®

A keying signal used in graphics systems – such as the Quantel Paintbox and the QPaintbox application. It can be drawn, derived from picture information, or both. It can be used to define the area of an object, obscure part or all of an object, making it transparent or partially transparent, and used to control the application of paint… and more.

Stereoscopy

The process of making and presenting images using 'left eye' and 'right eye' cameras. The resulting 'left eye' and 'right eye' stereo images allow audiences to perceive depth into and out of the screen. Although the technique can add greatly to the viewing experience and is often referred to as '3D', viewers cannot look around objects – as would be the case with real 3D.



In stereoscopy, presenting objects from the left and right eyes' point of view in the same way that our eyes would look at them in the real world creates the depth effect. If the left and right eye images of an object are coincident at the screen, then it appears to be at the distance of the screen. If the left and right images on the screen are crossed over, with the right image on the left and the left image on the right, then the object appears to be in front of the screen as our eyes converge on the images. If the left and right images are not crossed over but closer together than the distance between our eyes (interocular distance generally taken as 63.5 mm for the average adult), then the object appears to be behind the screen as our eyes converge less. To show an object at infinity left and right images are shown spaced by the interocular distance.

The advent of digital media replacements for film has sparked the development in new shooting technologies that can be capable of making live 3D TV. But generally post production is needed to correct unwanted differences between left and right cameras and to finesse the point of view and perspective. Exhibition has become far easier with digital cinema projectors able to sequence left and right images replayed from one player into one projector. This removes the nightmare of trying to align two projectors and running two films in synchronism and in registration. Despite the best human efforts generic film artifacts such as weave, scratches and sparkles detracted from the quality of presentation. Now 3D cinema can be experienced at almost any digital cinema – not just at the big venues. A viewing system is required that can sequence the images into the correct eyes, such as Real D, Dolby or McNaughton. These require wearing glasses that are passive polarized (Real D), passive frequency based (Dolby) or active switched (McNaughton). Live shooting and easy exhibition means that live events can be shown on cinema screens – giving audiences a new experience and theatres a potential new revenue stream.

For television, 3D screens have been developed but are now only just being mass-produced, partly due to the lack of 3D material! NHK Technical Services (NTS) has produced sets that use filters on the front of the screen and so can be watched without glasses. Philips has also developed 3D TV screens using their WoWvx technology. Both Samsung and Mitsubishi use DLP technology for their 3D Ready screens that require viewers to wear active glasses. The greatest initial application may be for the virtual world of computer games.

See also: 3D, Stereoscopic 3D Post (White Paper)
Websites: Dolby www.dolby.com/professional/motion_picture/solutions_d3ddc.html
Philips www.inition.com
Samsung & Mitsubishi www.dlp.com/hdtv/3-d_dlp_hdtv.aspx

Stereoscopic Window (Stereoscopic)

The amount of stereo image available to the viewer is dictated by the frame surrounding a stereoscopic image, e.g. the size of TV or projection screen. This boundary is called the Stereo Window. Depending on their parallax objects will appear either in front, at or behind this window. IMAX has the largest window.

Stop

A ratio of amount of light where one stop represents a x2 change – doubling or halving of the amount of light. The operating range of film and electronic light sensors, such as CCDs and CMOS, are quoted in stops. Typically, a camera's shutter speed and the lens's aperture setting restrict the light arriving at the sensors/film so the mid brightness of the required scene corresponds to the middle of the sensor's or film's sensitivity range.

Stops are simply the expression of a ratio, not absolute values. As they represent doubling or halving of light, they are actually powers of 2. So

1 stop = x 2
2 stops = x 4
3 stops = x 8
4 stops = x 16 etc.

Note that cine lenses are often marked in f-stops (white) and T-stops (red). The former is a geometric relationship between focal length and aperture and does not take into account how much light is lost within a lens. T-stops do and represent the real working values. So, on a lens that loses a full stop in transmission (i.e. a 50-percent loss), f/8 would result in the same exposure as T11. F and T values are usually close on prime lenses but zoom lenses show a greater difference.

Storage capacity (for video and film)

This is just arithmetic. You can work all these figures out yourself but it's really useful having some of the key numbers already to hand. Using the ITU-R BT.601 4:2:2 digital coding standard for SD, each picture occupies a large amount of storage space – especially when related to computer storage devices such as DRAM and disks. So much so that the numbers can become confusing unless a few benchmark statistics are remembered. Fortunately the units of mega, giga and tera make it easy to express the vast numbers involved; 'one gig' trips off the tongue far more easily than 'one thousand million' and sounds much less intimidating.

Storage capacities for SD video can all be worked out directly from the 601 standard. Bearing in mind that sync words and blanking can be re-generated and added at the output, only the active picture area need be stored on disks. In line with the modern trend of many disk drive manufacturers, kilobyte, megabyte and gigabyte are taken here to represent 10^3, 10^6 and 10^9 respectively.

Every line of a 625/50 or 525/60 TV picture has 720 luminance (Y) samples and 360 each of two chrominance samples (Cr and Cb), making a total of 1,440 samples per line.

625/50 format

There are 576 active lines per picture creating 1440 x 576 = 829,440 pixels per picture.

Sampled at 8 bits per pixel (10 bits can also be used) a picture is made up of 6,635,520 bits or 829,440 8-bit bytes – generally written as 830 kB.

With 25 pictures a second there are 830 x 25 = 20,750 kbytes or 21 Mbytes per second.

525/60 format

There are 480 active lines and so 1,440 x 480 = 691,200 pixels per picture.

With each pixel sampled at 8-bit resolution this format creates 5,529,600 bits, or 691.2 kbytes per frame. At 30 frames per second this creates a total of 21,039 kbytes, or 20.7 Mbytes per second.

Note that both 625 and 525 line systems require approximately the same amount of storage for a given time – 21 Mbytes for every second. To store one hour takes 76 Gbytes. Looked at another way each gigabyte (GB) of storage will hold 47 seconds of non-compressed video. 10-bit sampling uses 25% more storage.

If compression is used, and assuming the sampling structure remains the same, simply divide the numbers by the compression ratio. For example, with 5:1 compression 1 GB will hold 47 x 5 = 235 seconds, and 1 hour takes 76/5 = 18 GB (approx). The storage requirement for VBR compression cannot be precisely calculated but there is usually some target average compression ratio or data rate figure quoted.

Mobile/Wireless/Web

All media are limited by the bandwidth available in the transmission/delivery channel. The most restricted cases are found in wireless and mobile applications where there are a variety of screen sizes, shapes and resolutions ranging from VGA PDAs (480x640) and some 3G phones with up to 320x240, or 176x144 pixels and frame rates down to 15Hz.

HD

There are many video formats for HD but the 1080 x 1920 format is popular. Using 4:2:2 sampling, each line has 1920 Y samples and 960 each of Cr and Cb = 3840 samples per line. So each picture has 3840 x 1080 = 4.147 M samples. For 10-bit sampling each picture has the equivalent data of 5.18 M (8-bit) bytes. Assuming 30 pictures (60 fields) per second these produce 155 M bytes/s – 7.4 times that of SD. An hour of storage now needs to accommodate 560 GB.

2K and 4K

2K is a format used in digital film production that uses 4:4:4 10-bit sampling and RGB color space with an image size of 2048 x 1536, and has 24 frames per second. This makes one frame 11.80 MB, and an hour of storage 1.04TB. Note that applied to digital cinema exhibition, the 2K pixel size is 2048 x 1080, and the color space is X´Y´Z´ and uses 12-bit 4:4:4 sampling, as defined by the DCI. The 4K image size is increasingly being used for digital movies. It is a x2 version of 2K, making x4 the pixel area.

Here are some popular TV and digital film formats showing the volume of their uncompressed data. Compression of up to 100:1 is applied to MPEG-2 TV transmissions – over 100:1 may be used with more advanced codecs such as MPEG-4 and VC-1. DCI have given a maximum data rate for replay rate for digital cinemas of 250 Mb/s. Here JPEG 2000 compression is used and there is no inter-frame compression; this works out at a compression of about 6.4:1 for 2K and 25.5:1 for 4K.

Format	Sampling	Image size (H x V)	One Frame MB	Data rate Mb/s	One Hour GB
320/15P (3G phone)	4:1:1 8-bit	320 x 240	0.12	14.4	6.5
525/60I	4:2:2 8-bit	720 x 480	0.69	166	76
625/50I	4:2:2 8-bit	720 x 576	0.83	166	76
720/60P	4:2:2 10-bit	1280 x 720	2.3	1104	500
1080/60I	4:2:2 10-bit	1920 x 1080	5.2	1248	560
1080/25P (RGB)	4:4:4 10-bit	1920 x 1080	7.8	1560	700
1080/60P (RGB)	4:4:4 10-bit	1920 x 1080	7.8	3744	1680
2K/24P (DCI cine)	4:4:4 12-bit	2048 x 1080	10	1913	860
2K/24P (prod)	4:4:4 10-bit	2048 x 1536	12	2304	1036
4K/24P (DCI cine)	4:4:4 12-bit	4096 x 2160	39.8	7650	3442
4K/24P (production)	4:4:4 10-bit	4096 x 3072	48	9216	4144

See also: Byte, Dylan, Into digits (Tutorial 1), ITU-R BT.601, ITU-R BT.709, SMPTE 272M

Streaming (video and/or audio)

Refers to supplying a constant service, often realtime, of a medium. Although broadcast TV has done this from the beginning and SDI streams data, the term is one more usually associated with delivery by networks, including the Internet. The transmission comprises a stream of data packets which can be viewed/heard as they arrive though are often buffered, stored slightly in advance of viewing, to compensate for any short interruptions of delivery. For the Internet, media is usually highly compressed to offer acceptable results with 28 kb/s for audio and upwards of 64 kb/s for video. There are three predominant video streaming solutions: RealNetworks with RealVideo, RealAudio and RealPlayer, Microsoft Windows Media and Apple Quicktime – each with their particular advantages. As Internet transfers are not deterministic, pictures and sound may not always be constantly delivered.

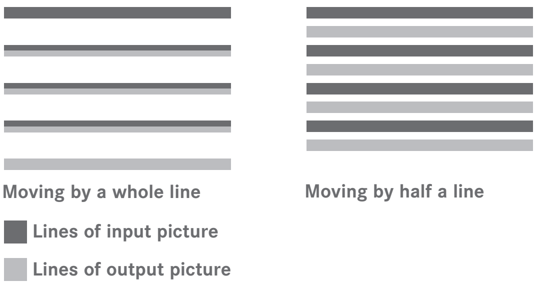
See also: File transfer, Isochronous

Structured Query Language (SQL)

A popular language for computer database management. It is very widely used in client/server networks for PCs to access central databases and can be used with a variety of database management packages. It is data-independent and device-independent so users are not concerned with how the data is accessed. As increasing volumes of stored media content are accessible over networks, SQL is able to play a vital role in finding any required items.

Sub-pixel

A spatial resolution smaller than that described by a pixel. Although digital images are composed of a matrix of pixels it can be very useful to resolve image detail to smaller than pixel size, i.e. sub-pixel. For example, the data for generating a smooth curve on the screen needs to be created to a finer accuracy than the pixel grid itself – otherwise the curve will look jagged. Again, when tracking an object in a scene, executing a DVE move, or calculating how a macroblock in MPEG-4 AVC coding moves from one picture to another, the size and position of the manipulated picture or element must be calculated, and the picture resolved, to a far finer accuracy than the that of whole pixels – otherwise the move will appear jerky or wrong.



Moving an image with sub-pixel accuracy requires picture interpolation as its detail, that was originally placed on lines and pixels, now has to appear to be where none may have existed, e.g. between lines. The original picture has to be effectively rendered onto an intermediate pixel/line position. The example of moving a picture down a whole line is achieved relatively easily by re-addressing the lines of the output. But to move it by half a line requires both an address change and interpolation to take information from the adjacent lines and calculate new pixel values. Good DVEs and standards converters work to a grid many times finer than the line/pixel structure.

See also: Pixel, Tracking

S

Switch (network)

Connecting network users via a switch means that each can be sending or receiving data at the same time with the full wire-speed of the network available. This is made possible by the aggregate capacity of the switch. So, for example, an eight-port Gigabit Ethernet switch will have an aggregate capacity of 8 Gb/s. This means many simultaneous high-speed transactions taking place without interruption from other users. The Internet is connected by thousands of very high speed network switches.

See also: CSMA/CD, Hub

SXRD

Silicon X-tal (crystal) Reflective Display, a reflective liquid crystal micro-display from Sony used in the first commercially available 4K-sized projectors. The display chip has 4096 x 2160 pixels on one-and-a-half inches of silicon. The design maintains a uniform, ultra-thin liquid crystal cell gap without any spacers in the image area – contributing to contrast performance, claimed as 4000:1. Its Vertically Aligned Nematic (VAN) liquid crystal changes state fast enabling speeds up to 200 f/s while minimizing image smear. HDTV-sized SXRD chips are already used in Sony consumer products, including a front projector and rear projection televisions up to 70 inches.

See also: Projectors (digital)

Synchronous (data transfer)

This carries separate timing information (clock data) for keeping send and receive operations in step. The data bits are sent at a fixed rate so transfer times are guaranteed but transfers use more resources (than asynchronous) as they cannot be shared. Applications include native television connections, live video streaming and SDI. Operation depends on initial negotiation at send and receive ends but transfer is relatively fast.

See: Asynchronous, Isochronous, SDI

Table 3 (ATSC)

Table 3 of the ATSC DTV Standard, Annex A, summarizes the picture formats allowable for DTV transmission in the USA. Any one of these may be compressed using MPEG-2 and transmitted. An ATSC receiver must be able to display pictures from any of these formats.

Vertical size value	Horizontal size value	Aspect ratio information	Frame rate code	Progressive sequence
1080*	1920	1,3	1,2,4,5	1
			4,5	0
720	1280	1,3	1,2,4,5,7,8	1
480	704	2,3	1,2,4,5,7,8	1
			4,5	0
	640	1,2	1,2,4,5,7,8	1
			4,5	0

ATSC Annexe A, Table 3 Picture formats

Legend

Aspect Ratio: 1 = square samples, 2 = 4:3 display aspect ratio, 3 = 16:9 display aspect ratio

Frame Rate: 1 = 23.976 Hz, 2 = 24 Hz, 4 = 29.97 Hz, 5 = 30 Hz, 7 = 59.94, 8 = 60Hz

Vertical Scan: 0 = interlaced scan 1 = progressive scan

**Note that 1088 lines are actually coded in order to satisfy the MPEG-2 requirement that the coded vertical size be a multiple of 16 (progressive scan) or 32 (interlaced scan).*

T

The wide range of formats in Table 3 caters for schemes familiar to television and computers and takes account of different resolutions, scanning techniques and refresh rates. For each frame size, frame rates are available to provide compatibility with existing transmission systems and receivers. 29.97 Hz is needed to keep step with NTSC simulcasts – this is not required once NTSC is no longer transmitted! 30 Hz is easier to use, and does not involve considerations such as drop-frame timecode. 24 Hz progressive (24P) offers compatibility with film material. A choice of progressive or interlaced scanning is also available for most frame sizes (see Progressive and Interlaced).

Table 3 is concerned with video formats to be handled in the ATSC system rather than defining standards for video production. ATSC's Table 1 of annex A refers to the standardized video production formats likely to be used as inputs to the compression table.

Video standard	Active lines	Active samples/line
SMPTE 274M	1080	1920
SMPTE S17.392	720	1280
ITU-R BT.601-4	483	720

ATSC Annex A, Table 1: Standardized video input formats

Targa (.TGA)
An image file format widely used in computer systems. It was developed by Truevision Inc. and there are many variations of the format.

TBC
Timebase Corrector. This is often included as a part of a VTR to correct the timing inaccuracies of the pictures read from the tape. Early models were limited by their dependence on analog storage devices, such as ultrasonic glass delay lines. This meant that VTRs, such as the original quadruplex machines, had to be mechanically highly accurate and stable to keep the replayed signal within the correction range (window) of the TBC – just a few microseconds. The introduction of digital techniques made larger stores economic so widening the correction window and reducing the need for especially accurate, expensive mechanical engineering. Digital TBC has had a profound effect on VTR design – and price. Quantel's first product was a digital TBC for use with IVC VTRs.

TCP/IP
Transfer Control Protocol/Internet Protocol. A set of standards that enables the transfer of data between computers. Besides its application directly to the Internet it is also widely used throughout the computer industry. It was designed for transferring data files rather than large files of television or film pictures. Thus, although TCP/IP has the advantage of being widely compatible it is a relatively inefficient way of moving picture files.

See also: FTP, IP

T-DMB
See DMB

Timeline
A graphical representation of editing, compositing, grading or other processes – usually as a horizontal line. This works well with disk-based operations providing instant access to any part of the process and, hopefully, to all the footage, decisions, associated tools and their settings.

TIFF (.TIF)
Tagged Image File Format. A bit-mapped file format for scanned images – widely used in the computer industry. There are many variations of this format.

Technical grade
A technical grade is a lower contrast scan to include all highlights and lowlights. Technical grades are widely used with virtual telecines and DI as they preserve all the useful dynamic range of film into the post production process.

Telecine
Device for converting film images into SD or HD video in realtime. The main operational activity here is color grading which is executed on a shot-by-shot basis and absorbs considerable telecine time. This includes the time needed for making grading decisions and involves significant handling of the film – spooling and cueing which risks film wear and damage – besides the actual transfer time. The output of a telecine is digital video (rather than data files).

Digital technology has moved the transfer process on. Now, adding a disk store or server can create a virtual telecine enabling the film-to-digital-media transfer to run as one continuous operation. Whole film spools can be scanned in one pass, with useful footage selected by an EDL. In this case the telecine may be termed a Film Scanner – creating image files (rather than digital video) that contain sufficient latitude for downstream grading.

See: Grading, Film Scanner

Threading
A technique that allows a (computing) process to be shared among several processors with the objective of completing the process more quickly than would be possible when using a single processor. Modern multi-core (processor) PC chips offer the potential for doing this but most, if not all, commonly used PC application programs are not designed for this. So, to provide faster processing for multiple tasks, multiprocessing is used where the programs (threads) are divided to run simultaneously on different cores to provide faster processing for multiple tasks.

Timing and Timer
Timing refers to the amount of the separate R, G and B lights that are used to expose film in a laboratory as a part of the grading process. The term is sometimes also applied to color grading during telecine transfers. The timer is one who decides and controls the lights' timing.

See also: Color Timing, Grading, Lights

Tracking (image)

Following a defined point, or points, in the pictures of a clip. Initially this was performed by hand, using a DVE but was laborious, difficult and limited to only down to pixel accuracy. Now image tracking is widely used, thanks to the availability of automatic point tracking operating to sub-pixel accuracy. The tracking data can be applied to control DVE picture moving for such applications as removal of film weave, replacing 3D objects in moving video, wire removal, etc.

Advanced multiple point tracking is sometimes used to analyze images in 3D, so allowing a whole raft of computer-generated material to be move-matched for compositing into live scenes – blurring the boundaries of live and synthetic imagery.

See also: Corner pinning, Sub-pixel

Triage

See: Digitizing time

True HD

This has no strict technical meaning but is marketing hype. The ATSC says that all HD, 720P, 1080I and 1080P are all true HD, but the term has tended to be associated with 1080P often in advertising – but this is nothing official. Not to be confused with… TrueHD.

TrueHD

Dolby's 'next-generation' lossless technology developed for high-definition disk-based media (HD DVD and Blu-ray Disc). It includes 'bit-for-bit' lossless coding up to 18 Mb/s and support for up to eight channels of 24-bit, 96 kHz audio. It is supported by HDMI.

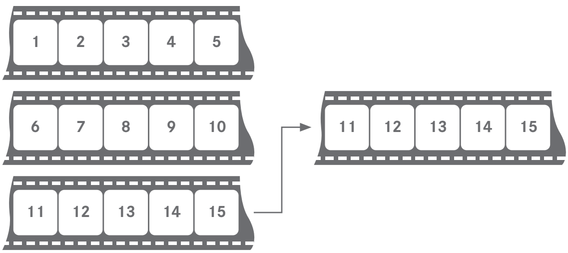
Website: www.dolby.com

True random access

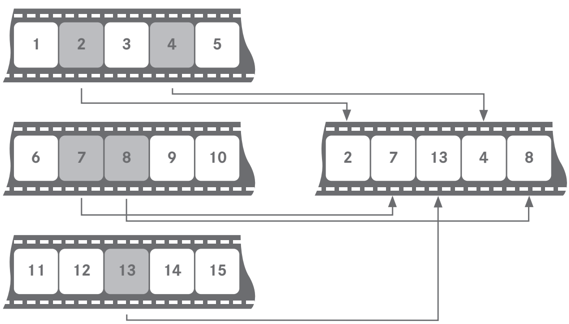
Quantel term for the ability to continuously read any frame, or sequence of frames, in any order at or above video (or realtime) rate, a part of FrameMagic. A true random access video store (usually comprising disks) can allow editing which offers rather more than just quick access to material. Cuts are simply instructions for the order of replay and involve no copying, so adjustments can be made as often and whenever required. This results in instant and very flexible operation. At the same time technical concerns associated with fragmentation do not arise as the store can operate to specification when fully fragmented, ensuring full operation at all times. This aspect is particularly important for server stores.

See also: Consolidation, Fragmentation, FrameMagic, Simultaneous true random access, Server (video), Uncommitted editing

Random Access



True Random Access



TrueType (fonts)

The TrueType vector font format was originally developed by Apple Computer, Inc. The specification was later released to Microsoft. TrueType fonts are therefore supported on most operating systems. Most major type libraries are available in TrueType format. There are also many type design tools available to develop custom TrueType fonts. Quantel equipment supports the import of these and other commercially available fonts.

Truncation

Removal of the least significant bits (LSBs) of a digital word – as could be necessary when connecting 10-bit video equipment into 8-bit video equipment, or handling the 16-bit result of digital video mixing on an 8-bit system. If not carefully handled truncation can lead to unpleasant artifacts on video signals – such as contouring. Quantel invented Dynamic Rounding to handle the truncation of digital image data so that the value of the dropped bits is contained in the remaining bits.

See also: Dynamic Rounding

UHD

Ultra HD developed by NHK Labs has a format of 7680x4320 (16 times the area of 1920 x 1080 HD) at 60 f/s and with 22.2 audio. This remains a lab project with possible consumer product as far away as 20 years. Presentations at big trade shows (NAB, IBC) have been impressive.

Uncommitted editing

Editing where the decisions are made and the edits completed but any can still easily be changed. This is possible in an edit suite with FrameMagic that includes true random access editing – where the edits need only comprise the original footage and the edit instructions. Nothing is re-recorded so nothing is committed. This way, decisions about any aspect of the edit can be changed at any point during the session, regardless of where the changes are required. Where new frames are generated, such as in mixes, dissolves and compositing, all the tools and their settings are available – preferably on the edit timeline.

See also: True random access

Unicode

Unicode allows computers to consistently represent and manipulate text in most of the world's writing systems – 30 are currently implemented – describing about 100,000 characters. Before Unicode, there were hundreds of different encoding systems to assign numbers to characters, and no single one could contain enough characters to cover all languages – in Europe alone. Unicode provides a unique number for every character, regardless of platform, program or language. The Unicode Standard is widely adopted and supported by the computer industry.

Website: www.unicode.org

Up-res

The process which increases the size, or number of pixels used to represent an image by interpolating between existing pixels to create the same image on a larger format. There is no implied change of vertical scan rate. Despite its name, the process does not increase the resolution of the image; it just spreads the same over a larger canvas. The quality of the result depends on that of the interpolation. Speed is an issue for realtime work, as good quality requires a large amount of processing – which increases with the picture area.

See also: Down-res, Format conversion

USB

Universal Serial Bus – now available as USB 2.0 which, with 480 Mb/s maximum transfer rate, offers potentially useful connectivity for media applications on PCs and Macs. It is very cheap and widely used for connecting PC peripherals. It is a PAN, and so the service provided to any one device depends on their specification and on what other connected devices are doing. Actual speeds achieved for bulk data transfers are about 300 Mb/s – but this is likely to rise.

See also: IEEE 1394

Vaporware

Software or hardware that is promised or talked about but is not yet completed – and may never be released.

See also: RSN

Variable bit rate (VBR) compression

While many video compression schemes are ‘constant bit rate’ – designed to produce fixed data rates irrespective of the complexity of the picture, VBR offers the possibility of fixing a constant picture quality by varying the bit-rate according to the needs of the picture. This allows the images that require little data, like still frames in MPEG-2, to use little data and to use more for those that need it, to maintain quality. The result is an overall saving in storage, as on DVDs, better overall quality, or more efficient allocation of total available bit-rate in a multi-channel broadcast multiplex.

See also: Constant bit rate, DVD, Statistical multiplexing

Varicam

Panasonic camcorder based on DVCPRO HD that was the first to offer variable frame rates from 4 to 60Hz at 1280 x 720P. So, if working at a nominal 24 fps, the system offers x 6 speed up (undercranking) to x 2.5 slow down (overcranking). The system works by continuously recording 60 f/s to tape while the images are captured at the appropriate rate. Then the relevant useful frames are flagged. Editing equipment with a Varicam interface can use the flag to record the right frames and so replay them at the right speed (e.g. Panasonic VTR AJ-HD1700 and Quantel editing systems).

See also: VFR

VC-1

VC-1 is a video codec specification (SMPTE 421M-2006) and implemented by Microsoft as Windows Media Video (WMV) 9, and specified in HD DVD and Blu-ray Disc, and many others. It is designed to achieve state-of-the-art compressed video quality at bit rates ranging from very low to very high with low computational complexity for it to run well on PC platforms. The codec can handle 1920 x 1080 at 6 to 30 Mb/s for high-definition video and is capable of higher resolutions such as 2K for digital cinema, and of a maximum bit rate of 135 Mb/s. An example of very low bit rate video would be 160 x 120 pixel at 10 kb/s.

VC-1 uses some similar transforms to H.261 (1990, the first practical digital coding standard) but much more like H.264/AVC. It includes some distinctive innovations and optimizations. These include 16-bit transforms to help to minimize decoder complexity and interlace coding using data from both fields to predict motion compensation. Also fading compensation improves compression efficiency for fades to/from black and a modified de-blocking filter helps handling areas of high detail.

Individual opinions differ but broadly speaking VC-1 offers at least similar performance and efficiency to H.264/AVC – some say it looks better. VC-1 offers a number of profiles for coding features, and levels of quality combinations defining maximum bit rates. These have a wide range from 176 x 144/15P which may be used for mobile phones, to 2K (2048 x 1536/24P) for movie production.

Profile	Level	Max Bit Rate	Resolutions and Frame Rate
Simple	Low	96 Kb/s	176 x 144 @ 15 Hz (QCIF)
	Medium	384 Kb/s	240 x 176 @ 30 Hz
			352 x 288 @ 15 Hz (CIF)
Main	Low	2 Mb/s	320 x 240 @ 24 Hz (QVGA)
	Medium	10 Mb/s	720 x 480 @ 30 Hz (480p)
			720 x 576 @ 25 Hz (576p)
	High	20 Mb/s	1920 x 1080 @ 30 Hz (1080p)
Advanced	L0	2 Mb/s	352 x 288 @ 30 Hz (CIF)
	L1	10 Mb/s	720 x 480 @ 30 Hz (NTSC-SD)
			720 x 576 @ 25 Hz (PAL-SD)
	L2	20 Mb/s	720 x 480 @ 60 Hz (480p)
			1280 x 720 @ 30 Hz (720p)
	L3	45 Mb/s	1920 x 1080 @ 24 Hz (1080p)
			1920 x 1080 @ 30 Hz (1080i)
			1280 x 720 @ 60 Hz (720p)
	L4	135 Mbps	1920 x 1080 @ 60 Hz (1080p)
			2048 x 1536 @ 24 Hz

See also: MPEG-4
Websites: www.microsoft.com
www.smpte.org

VC-2

Currently undergoing standardization by SMPTE, VC-2 (also known as Dirac Pro) is a video codec technology developed by the BBC. VC-2 is open source and royalty-free for all to use. It is an intra-frame compression scheme aimed at professional production and post production. Compression ratios are in the range 2:1 – 16:1, and typical VC-2 applications are seen to include desktop production over IP networks, reducing disk storage bandwidth in D-Cinema production and moving HD video over legacy infra-structure. A current application provides near lossless compression to enable the use of HD-SDI to carry 1080/50P and 1080/60P, which would otherwise require new 3G SDI infrastructure.

Website: http://www.bbc.co.uk/rd/pubs/whp/whp-pdf-files/WHP159.pdf

VC-3

Avid's DNxHD codec currently undergoing standardization by SMPTE may be given this designation.

See also: DNxHD

Vector fonts

Fonts that are stored as vector information – sets of lengths and angles to describe each character. This offers the benefits of using relatively little storage and the type can be cleanly displayed at virtually any size. However it does require that the type is RIPped before it can be used – requiring significant processing power if it is to be used interactively for sizing and composing into a graphic. Quantel's range of graphics and editing equipment uses vector fonts.

See also: TrueType

Versioning

In recent times demand for producing the required versions of a finished production has ballooned. Historically this used to involve making copies from the edited and graded master to various videotape formats and, via a standards converter, to other video standards (e.g. NTSC to PAL). Now technical variations involve many more formats being supplied, including Web, mobile, HD and SD TV, DVD and film, as well as a variety of display systems including CRT, LED, Plasma and digital cinema. Aside from the technical needs, other requirements such as commercial, language and religious influences are among the many factors that can be causes for more versions.

Today versioning is big business, as the number of versions can run to many tens and involve much more than simply making copies of the master. For example, work may involve re-grading to suit different viewing conditions, grain management to suit different compression and display technologies, re-insertion of text or images to suit different regions or countries, pricing (for commercials) adding or removing shots or scenes for censoring, etc. Generally, for this to be done efficiently and effectively requires nonlinear editing in an uncommitted environment; where original footage and all the post processes that produced the master are available for recall and allow further adjustment, to re-make the result in a short time.

VFR

Variable Frame Rate shooting has, until recently, only been possible with film cameras as all electronic cameras work at fixed frame rates. Panasonic's HD Varicam was the first to offer variable speeds, with frame rates from 4 to 60 f/s in one-frame increments. Sony's XDCAM HD can offer the same range. There are also more specialized cameras and recorders able to capture HD frame rates up to 1000 f/s, or more. ARRI Media's collaboration with Quantel (storage and processing) and NAC Image Technology (camera) created the Tornado system in 2004, allowing viewers to see near-live images from the very different world of extreme slow motion. ARRI Media now offers from 1-300 f/s with its Hi-Motion system enabling instant replays. These cameras exceed the performance of film, and are hugely easier and lower cost to run. VFR is seen as a significant step forward for digital cinematography.

See also: Varicam, Digital cinematography
Website: www.nacinc.eu
www.panasonic.com/pbds

Video over IP

See DVB over IP

Video projection

Video projector technology can now show up to 4K images (4096 x 2160) on large cinema screens. Such technology is a major part of Digital Cinema development. There are two major technologies used for large-scale projection, D-ILA and DLP Cinema.

See D-ILA, DLP cinema

Viper

See Digital Cinematography

Virtual telecine

See Telecine

VITC

Vertical Interval Timecode (pronounced 'vitsy'). Timecode information in digital form, added into the vertical blanking of a TV signal. This can be read by the video heads from tape at any time pictures are displayed, even during jogging and freeze but not during spooling. This effectively complements LTC ensuring timecode can be read at any time.

See also: LTC

VPB

An open Quantel standard file format in which full images, browse images, stencils and cut-outs are transferred, and used in a wide range of third-party applications. The format is based on YCrCb 4:2:2 sampling to ITU-R BT.601 specifications. There are also RGB and CMYK file types.

VSB

Vestigial Sideband modulation – an established modulation technique which is used in the RF (radio frequency) transmission subsystem of the ATSC Digital Television Standard. The 8-VSB system has eight discrete amplitude levels supporting a payload data rate of 19.28 Mb/s in a 6 MHz TV channel. There is also a high data rate mode – 16 VSB – designed for CATV (cable television) and supporting a payload of 38.57 Mb/s but this has yet to be implemented.

Things move on; E-VSB, Enhanced-VSB, was approved by ATSC in 2004 as an amendment to the A/53C DTV Standard as an optional transmission mode with additional forward error correction coding layers to help reception under weaker signal conditions. This was responding to the wishes broadcasters for more flexibility in DTV. E-VSB allows broadcasters to trade-off data rate for a lower carrier-to-noise threshold for some services, e.g. "fall back" audio, and targeted at receivers with indoor antennas, non-realtime transmissions of file-based information, and more.

Website: www.atsc.org and search for VSB on www.broadcast.harris.com

WAV (.WAV)

An audio file format developed by Microsoft that carries audio that can be coded in many different formats. Metadata in WAV files describes the coding used. To play a WAV file requires the appropriate decoder to be supported by the playing device.

Website: www.microsoft.com

Wavelet

A compression technique in which the image signal is broken down into a series of frequency bands. This is a very efficient but the processing is more complex than for DCT-based compression that uses Fourier transforms. Although some wavelet-based compression was used by some manufacturers now all wavelet compression used in the media industry is JPEG 2000. It is prevalent in DCI digital cinema, is used in some new camcorders and is increasingly used in contribution and distribution circuits.

See also: JPEG 2000

WIBNI

Wouldn't It Be Nice If... A wish – usually referring to a hoped-for new feature on a piece of equipment.

Widescreen

A TV picture that has an aspect ratio wider than the 'normal' 4:3 – usually 16:9 – while still using the normal 525/60 or 625/50 or SD video. 16: 9 is also the aspect ratio used for HDTV. There is an intermediate scheme using 14:9 which is found to be more acceptable for those still using 4:3 displays. Widescreen is used on some analog transmissions as well as many digital transmissions. The mixture of 4:3 and 16:9 programming and screens has greatly complicated the issue of safe areas.

See also: Safe Area

WiMAX

Worldwide Interoperability for Microwave Access (IEEE 802-16 and ETSI HiperMAN), is a standards-based technology enabling the delivery of last-mile wireless broadband access as an alternative to cable and DSL. Unlike Wi-Fi, this provides symmetrical bandwidth (equal upload and download speeds) over many kilometers with stronger encryption (3DES or AES). It connects between network endpoints without the need for line-of-sight of the base station for fixed, nomadic, portable and mobile wireless broadband. Typical cell radius is 3-10 km, delivering capacity up to 40 Mb/s per channel, for fixed and portable access – enough bandwidth to support hundreds of businesses and thousands of homes. Mobile networks are expected to provide up to 15 Mb/s capacity within 3 km cell radius. WiMAX technology already has been incorporated in some notebook computers and PDAs, allowing urban areas and cities to become MetroZones for portable outdoor broadband wireless access.

See also: OFDMA
Website: www.wimaxforum.org

Windows Media

Audio and video compression schemes, encoders and decoders (players) devised by Microsoft. The latest Windows Media 9 (WM9) uses the VC-1 compression codec with similar efficiency as MPEG-4 H.264/AVC.

WirelessHD (WiHD)

A formal special interest group comprising consumer electronics and other technology companies (LG Electronics, Matsushita (Panasonic), NEC, Samsung, SiBEAM, Sony and Toshiba), formed to promote and enable the rapid adoption, standardization and multi-vendor interoperability of WirelessHD technology worldwide. It will provide a wireless digital interface to combine uncompressed high-definition video, multi-channel audio, intelligent format and control data, and Hollywood-approved content protection. It means the elimination of audio and video cables and short distance limitations. First-generation implementation high-speed rates range from 2-5 Gb/s for CE, PC, and portable devices, with up to 20 Gb/s eventually possible.

WM9 and WMV

See: VC-1

Word clock

Clock information associated with AES/EBU digital audio channels. Synchronous audio sampled at 48 kHz is most commonly used in TV. The clock is needed to synchronize the audio data so it can be read.

See also: AES/EBU audio

Workflow

Literally, the flow of work. The wide-scale adoption of digital technology in the production chain of television and media in general has produced many possibilities for arranging exactly where and in what order the various required steps are done. This can be one of the big advantages of ‘digital’. In many cases this does not follow the traditional analog path where there were few, if any, choices. Today there are any number of ways to arrange workflows but only the good ones will offer the most efficient and fast way of achieving results. Important elements are ensuring there are no bottlenecks – powerful enough processing to achieve fast results and fast connections to make sure data is available where and when you want it. Often the better workflows involve less movement of data as more tasks are completed in one area.

Workflow patterns are altered by technology. For example, traditional film grading is completed prior to editing and any visual effects work. Today it is possible to edit a digital film and then grade while seeing the material in context.

WORM

Write Once/Read Many – describes storage devices on which data, once written, cannot be erased or re-written. This applies to some optical disks that offer high recording densities and are removable, making them very useful for archiving. CD-R and DVD-R are examples.

See also: Optical disks

WYSIWYG

What You See Is What You Get. Usually, but not always, referring to the accuracy of a screen display in showing how the final result will look. For example, a word processor screen showing the final layout and typeface that will appear from the printer. Or in an edit suite, does the monitor show exactly what will be placed on the master recording? This subject requires more attention as edited masters are now commonly output to a wide variety of 'deliverables' such as SD video, HD video, DVD, VHS, digital projection and film. Issues such as color, gamma and display aspect ratio may need consideration.

See also: Color Management

XDCAM

Sony camcorder products that use its Professional Disc (PD) technology, an application of Blu-ray Disc, as the recording medium. The product range includes camcorders, mobile and studio decks which are designed to take advantage of the size, weight, data speed and re-record features of the PD technology.

XDCAM camcorders use the DVCAM codec and record SD 4:1:1 (480-line) and 4:2:0 (576-line) video at 25 Mb/s onto a PD.

XDCAM HD camcorder images are native 1440 x 1080 and can be recorded as HDV: 1080/59.94I, 50I, 29.97P, 25P, and native 23.98P video using MPEG-2 MP@HL with compression and 4:2:0 sampling. Users can select 35 (HQ), 25 (SP), or 18 (LP) Mb/s bit rates according to picture quality and recording length requirements – ranging from 60 to 120 minutes. There are four channels of 16-bit, 48 kHz audio.

XDCAM EX takes the same ideas but records to solid state storage in place of Blu-ray disc.

See also: Professional Disc

X´Y´Z´

A mathematically defined absolute color space, CIE X´Y´Z´, also known as CIE 1931 color space, was created by the International Commission on Illumination (CIE) in 1931. It was not heard much of in the digital media industry until X´Y´Z´ was selected by DCI as the color space for digital cinema.

W
X

Y, Cr, Cb

The digital luminance and color difference signals in ITU-R BT.601 coding. The Y luminance signal is sampled at I3.5 MHz and the two color difference signals are sampled at 6.75 MHz co-sited with one of the luminance samples. Cr is the digitized version of the analog component (R-Y), likewise Cb is the digitized version of (B-Y). For the HD SMPTE 274M standard, sampling rates are 5.5 times greater – 74.25 MHz for Y and 37.125 MHz for Cr and Cb.

Y, R-Y, B-Y

These are the analog luminance, Y, and color difference signals (R-Y) and (B-Y) of component video. Y is pure luminance information whilst the two color difference signals together provide the color information. The latter are the difference between a color and luminance: red – luminance and blue – luminance. The signals are derived from the original RGB source (e.g. a camera or telecine).

The Y, (R-Y), (B-Y) signals are fundamental to much of television. For example in ITU-R BT.601 it is these signals that are digitized to make 4:2:2 component digital video, in the PAL and NTSC TV systems they are used to generate the final composite coded signal and in DTV they are sampled to create the MPEG-2 video bitstream.

See also: 4:2:2, Luminance, NTSC, Y,Cr,Cb, YUV

YUV

Convenient shorthand commonly – but incorrectly – used to describe the analog luminance and color difference signals in component video systems. Y is correct for luminance but U and V are, in fact, the two subcarrier modulation axes used in the PAL color coding system. Scaled and filtered versions of the B-Y and R-Y color difference signals are used to modulate the PAL subcarrier in the U and V axes respectively. The confusion arises because U and V are associated with the color difference signals but clearly they are not themselves color difference signals. Or could it just be because YUV trips off the tongue much more easily than Y, R-Y, B-Y? Go figure.

See also: PAL

Zits

Spots that occasionally appeared on the faces of picture tubes showing digital pictures when the technology was in its youth. These were caused by technical limitations but now that designs have matured, today zits only now appear during fault conditions.

Tutorial 1 – Into digits

Digital technology is sweeping our industry and affects many parts of our lives. Yet we live in an analog world. Light and sound naturally exist in analog forms and our senses of sight and hearing are matched to that. The first machines to capture, record and manipulate pictures and sound were analog but today it is far easier to do the jobs in the digital domain. Not only does this allow the use of the highly advanced digital components available from the computer industry but it also leads to many new capabilities that were impractical or simply impossible with analog.

The techniques used to move between the analog and digital worlds of television pictures are outlined here. Some of the pitfalls are shown as well as describing why the digital coding standards for standard definition and high definition television (ITU-R BT.601 and ITU-R BT.709) are the way they are.

Why digits?
The digital machines used in television are generally highly complex and many represent the state-of-the-art of digital technology. The initial reason for the popularity of digital techniques was that the scale of the computer industry ensured that the necessary electronic components were both relatively easily available and continued to develop. But the preference for digits is also because of their fidelity and the power they give to handle and manipulate images. Rather than having to accurately handle every aspect of analog signals, all digital circuits have to do is differentiate between, or generate, two electrical states – on and off, high and low, 1 and 0. To read, or correctly interpret, this information accurately requires only recognizing a 1 or 0 state, rather than the value of continuously varying analog signals. This is relatively easy and so leads to superb fidelity in multi-generation recordings, no losses in passing the signal from place to place, plus the potential of processing to produce effects, large-scale storage and many other techniques far beyond those available in analog.

Thirty-five years ago the technology simply did not exist to convert television pictures into digits. Even if it could have been done there were no systems able to process the resulting data stream at anything like realtime. Today digital machines have successfully reached every aspect of television production – from scene to screen. At the same time costs have tumbled so that today all new equipment, from broadcast professional to consumer level, is digital.

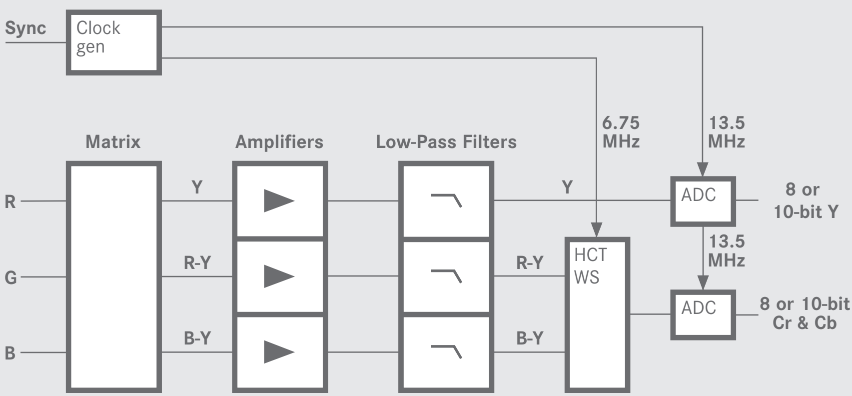
From analog to digital
Analog to digital conversion occurs in three parts: signal preparation, sampling and digitization. Initially, digitization involved working with television’s composite signals (PAL and NTSC) but this is now rare. Today it is the component signals (meaning separate signals that together make-up the full color signal), not composite, which are digitized according to the ITU-R BT.601 and ITU-R BT.709 digital sampling specifications for SD and HD respectively (film applications uses different ranges of sampling to these TV and video requirements).

‘601’ describes sampling at standard definition and is widely used in TV operations. Sampling for high definition, according to ITU-R BT.709, broadly follows the same principles, but works faster. Both standards define systems for 8-bit and 10-bit sampling accuracy – providing 2^8 (= 256) and 2^{10} (= 1024) discrete levels with which to describe the analog signals.

There are two types of component signals; the Red, Green and Blue (RGB) and Y, R-Y, B-Y but it is the latter which is by far the most widely used in digital television and is included in the ITU-R BT.601 and 709 specifications. The R-Y and B-Y, referred to as color difference signals, carry the color information while Y represents the luminance. Cameras, telecines, etc., generally produce RGB signals from their image sensors. These are easily converted to Y, R-Y, B-Y using a resistive matrix and filters. This is established analog technology used to prepare video for PAL or NTSC coding.

Signal preparation

The analog to digital converter (ADC) only operates correctly if the signals applied to it are correctly conditioned. There are two major elements to this. The first involves an amplifier to ensure the correct voltage and amplitude ranges for the signal are given to the ADC. For example, luminance amplitude between black and white must be set so that it does not exceed the range that the ADC will accept. The ADC has only a finite set of numbers (an 8-bit ADC can output 256 unique numbers – but no more, a 10-bit ADC has 1024 – but no more) with which to describe the signal. The importance of this is such that the ITU-R BT.601 and 709 standards specify this set-up quite precisely saying that, for 8-bit sampling, black should correspond to level 16 and white to level 235, and at 10-bit sampling 64 and 940 respectively. This leaves headroom for errors, noise and spikes to avoid overflow or underflow on the ADC. Similarly for the color difference signals, zero signal corresponds to level 128 (512 for 10-bit) and full amplitude covers only 225 (897) levels.



For the second major element the signals must be low-pass filtered to prevent the passage of information beyond the luminance band limit of 5.75 MHz and the color difference band limit of 2.75 MHz, from reaching their respective ADCs. If they did, aliasing artifacts would result and be visible in the picture (more later). For this reason low pass (anti-aliasing) filters sharply cut off any frequencies beyond the band limit. For HD, the principle remains the same but the frequencies are all 5.5 times higher, generally, depending on the HD standard being used.

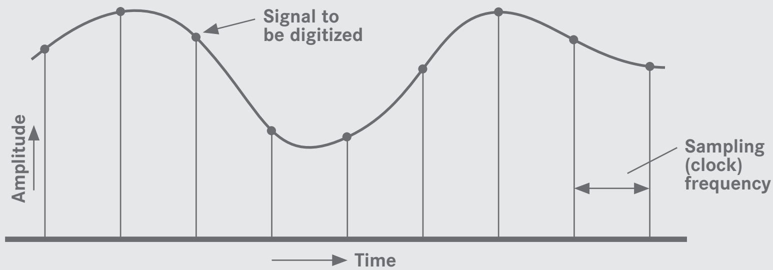
Sampling and digitization

The low-pass filtered signals of the correct amplitudes are then passed to the ADCs where they are sampled and digitized. Normally two ADCs are used, one for the luminance Y, and the other for both color difference signals, R-Y and B-Y. Within the active picture the ADCs take a sample of the analog signals (to create pixels) each time they receive a clock pulse (generated from the sync signal). For Y the clock frequency in SD is 13.5 MHz and for each color difference channel half that – 6.75 MHz – making a total sampling rate of 27 MHz (74.25 MHz, 37.125 MHz and 148.5 MHz respectively for HD). It is vital that the pattern of sampling is rigidly adhered to, otherwise onward systems, and eventual conversion back to analog, will not know where each sample fits into the picture – hence the need for standards! Co-sited sampling is used, alternately making samples of Y, R-Y, and B-Y on one clock pulse and then on the next, Y only (i.e. there are half the color samples compared with the luminance). This sampling format used in 601 is generally referred to as 4:2:2 and is designed to minimize chrominance/luminance delay – any timing offset between the color and luminance information. Other sampling formats are used in other applications – for example 4:2:0 for MPEG-2 compression used for transmission.

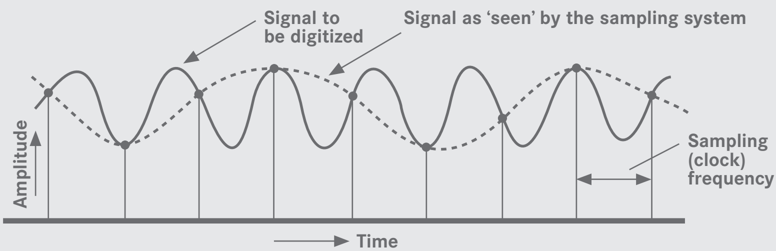
The amplitude of each sample is held and precisely measured in the ADC. Its value is then expressed and output as a binary number and the analog to digital conversion is complete. Note that the digitized forms of R-Y and B-Y are referred as Cr and Cb.

Sampling (clock) frequency

The (clock) frequency at which the picture signal is sampled is crucial to the accuracy of analog to digital conversion. The object is to be able, at some later stage, to faithfully reconstruct the original analog signal from the digits. Clearly using too high a frequency is wasteful whereas too low a frequency will result in aliasing – so generating artifacts. Nyquist stated that for a conversion process to be able to re-create the original analog signal, the conversion (clock) frequency must be at least twice the highest input frequency being sampled (see diagram below) – in this case, for luminance, 2 x 5.5 MHz =11.0 MHz. 13.5 MHz is chosen for luminance to take account of both the filter characteristics and the differences between the 625/50 and 525/60 television standards. It is a multiple of both their line frequencies, 15,625 Hz and 15,734.265 Hz respectively, and therefore compatible with both (see 13.5 MHz). Since each of the color difference channels will contain less information than the Y channel (an effective economy since our eyes can resolve luminance better than chrominance) their sampling frequency is set at 6.75 MHz – half that of the Y channel.



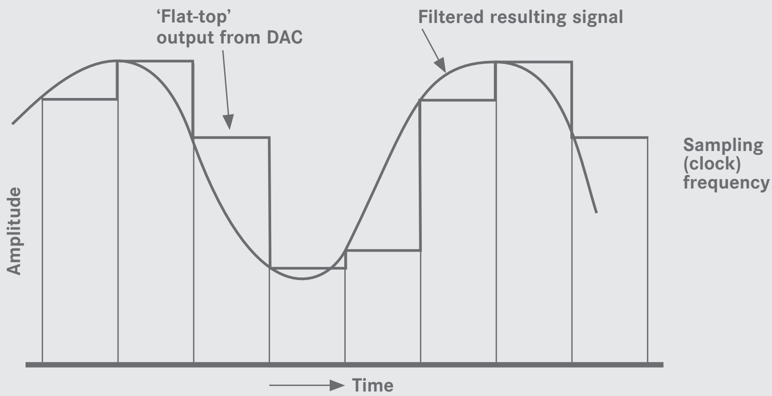
Correct: Sampling (clock) frequency is high enough to resolve the signal



Wrong: The signal frequency is too high for the sampling (clock) frequency, resulting in the wrong signal being seen by the sampling system

From digital to analog

Today, it is increasingly common for the digital signal to be carried right through to the viewer, so the signal would not require digital to analog conversion at all. Where D to A conversion is required, the digital information is fed to three digital to analog converters (DACs), one each for Y, Cr and Cb (digitized R-Y and B-Y), which are clocked in the same way and with the same frequencies as was the case with the ADCs. The output is a stream of analog voltage samples creating a 'staircase' or 'flat top' representation similar to the original analog signal (see figure below). The use of a sampling system imposes some frequency-dependent loss of amplitude which follows a Sinx/x slope. This means that the output amplitude curves down to zero at half the frequency of the sampling frequency, known as the Nyquist frequency. For example sampling at 13.5 MHz could resolve frequencies up to 6.75 MHz. Although the ITU-R BT.601 set-up is way off that zero point, the curved response is still there. This curve is corrected in the Sinx/x low-pass filters which, by losing the unwanted high frequencies, smoothes the output signal so it now looks the same as the original Y, R-Y, B-Y analog inputs. For those needing RGB, this can be simply produced by a resistive matrix.



Perfect results?

Today the whole analog to digital and digital to analog process is usually reliable and accurate. However there are inherent inaccuracies in the process. The accuracy of the clock timing is important and it should not vary in time (jitter). Also the accuracy of the ADCs in measuring the samples, though within the specification of the chip, may not be exact. This is a specialized task as each sample must be measured and output in just 74 nanoseconds, or 13.5 nanoseconds for HD. Equally the DACs may only be expected to be accurate to within their specification, and so they too will impose some degree of non-linearity into the signal. Even with perfect components and operation the process of sampling and reconstituting a signal is not absolutely accurate. The output is never precisely the same as the original signal. For this reason, plus cost considerations, system workflows are designed so that repeated digitization processes are, as far as possible, avoided. Today it is increasingly common for pictures to be digitized at, or soon after, the camera and not put back to analog, except for monitoring, until the station output, or, with DTV, until arriving at viewers' TV sets or set-top boxes; indeed in many cases the signal now remains digital throughout the entire production, distribution and viewing chain.

Tutorial 2 – Film basics

The film process is designed for capturing images from scenes that will be edited and copied for eventual projection onto hundreds or thousands of big cinema screens. This has been in operation for over 100 years and so has been developed and refined to a very high degree to precisely meet these objectives. The film stocks used in cameras have a characteristic that allows them to capture a very wide range of scene brightness with good color saturation to provide wide latitude for color correction after processing. Intermediate stocks used to copy the one original negative are designed to be as faithful to the original as possible. Print stocks provide the high contrast needed to produce a bright and good contrast image on the projector screen to overcome the background illumination in the theatre.

Television is different in many ways. For example, the results are always instantly viewable and are delivered, sometimes live, to millions of smaller screens. The sensors used in video cameras do not presently have the wide dynamic range of film and so shooting with them has to be more carefully controlled as the ability to correct exposure faults later is more restricted. Also the viewing conditions for video are different from cinema. Not many of us sit in a darkened room to watch television, so the images need to be brighter and more contrasted than for film.

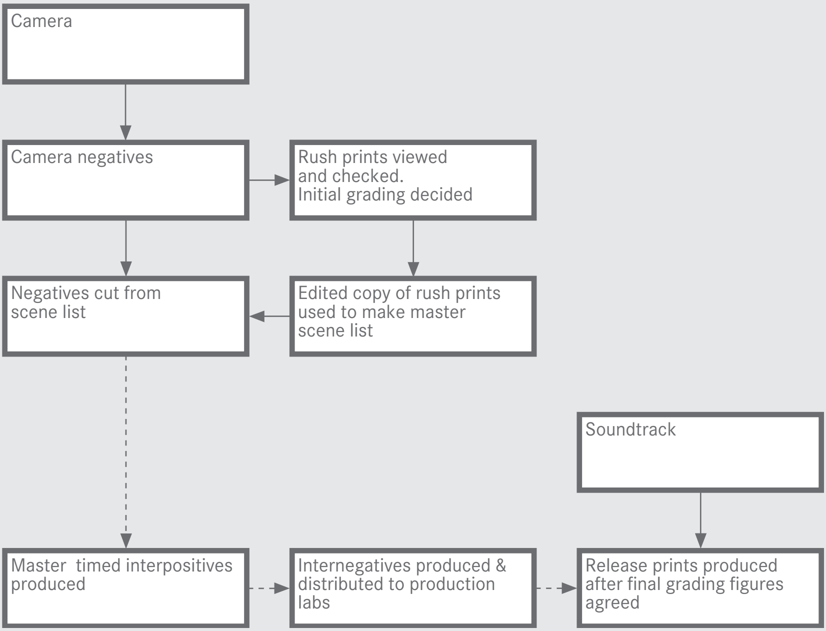
The three different basic types of film stock used – camera negative, intermediate and print – each have very specific jobs. Camera negative records as much detail as possible from the original scene, both spatially and in range of light to make that original detail eventually available on a multitude of internegatives from which are produced thousands of release prints for projection.

The Film Lab

Between the camera negative and the print there are normally two intermediate stages: Interpositive and Internegative. At each point more copies are made so that there are a large number of internegatives from which to make a much larger number of release prints. The object of these intermediate stages is purely to increase the numbers of negatives to print as clearly the precious and unique camera negative would be effectively destroyed with so much handling. The intermediate materials, interpositive and internegative, are exactly the same and designed to make, as near as possible, exact copies for each stage (with each being the negative of the previous stage). For this requirement the material has a gamma of 1.

But the release print is not just a film representation of the shot scenes: editing, visual effects, and grading – not to mention audio work – must take place between. This mainly works in parallel with the film processing path – partly to reduce handling the negative.

Camera negative is printed to make the rush prints which provide the first viewing of the shot material. Note that this will be at least several hours after the shoot so hopefully all the good takes came out well! The first edit decisions about what footage is actually required are made from the rush prints and with the aid of offline editing.



The negative cutter has the responsibility of cutting the unique footage according to the scene list. Initial grading is applied as the cut negative is transferred to interpositive. Should there be any further need of grading, instructions for this are sent with the internegatives to the print production labs. Any need of dissolves rather than cuts, or more complex visual effects, will require work from the optical printer or, these days, a digital film effects workstation.

Grading or Timing

Grading is the process of applying a primary color correction to the film copying process. The original camera negative may contain lighting errors which will mean that scenes shot on different days or times during the day need to look the same but simply do not. By effectively controlling the color of the light used to copy the negative to one of the intermediate stages these errors can be much reduced to produce a scene-to-scene match. Grading is carried out on a special system equipped with a video monitor displaying the current frame from the negative loaded onto it. Three controls provide settings of the red, green and blue 'printer' light values that adjust the amount of each of the three lights used to image the frame. These adjustments allow the operator to balance the color and brightness of the scenes in the movie.

This results in a table of corrections linked to the edge code of the original negative. This table may be stored on floppy disk or paper tape and used to control the optical printer making the copy. Most processing laboratories subscribe to a standard definition of the settings but this does not mean that setting defined at one processing lab can be used at another. The photochemical process is very complex and individual labs will vary. However they all aim toward a standard. The 'neutral' value for RGB printer lights is represented typically as between 25, 25, 25 to 27, 27, 27 – depending on which lab is used. To print an overexposed negative will require higher values and underexposed lower values. A change of 1 in the value represents $^{1}/_{12}{}^{th}$ of a stop adjustment in exposure. Differential adjustment of the values provides basic color correction.

This analog process is now often replaced by a digital process known as Digital Intermediate (DI).

White paper – Stereoscopic 3D post

Stereoscopic 3D is a hot topic; probably the biggest topic in Film and Broadcast right now. Well produced stereo 3D looks terrific. It will likely cause as big a change in our industry as the introduction of color or sound. That's great news for us all, as professionals and also as consumers. As an industry, we have a new stereo language to learn, new tricks to master and new headaches (sometimes literally) to think about avoiding. Right now there is a good level of discussion on shooting stereo and on displaying stereo. Much less discussion is happening on post producing stereo.

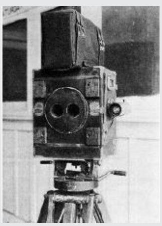
In this paper we'll take a practical look at the nuts and bolts of the stereo 3D post process. For the vast majority of us, including this author, stereo is a learning experience that is just starting. Luckily for us, there is already a fund of current knowledge from people posting stereo now.

Before looking at where we are now, we need to understand how we got here. So, a little bit of history first.

Early optical Stereo post

Back in the age of the 3D 'creature features' in the 50's, stereo post was very 'hit and miss'. There were four main problems for the post houses:

- The movies were very complex to shoot, (you had no idea what 3D shots would look like until a day or more later). Inconsistent photography meant the post houses were starting off with very problematic material.
- Post itself was very slow and difficult. Traditional optical and chemical effects are cumbersome enough even with a conventional 2D movie. They are a nightmare in 3D as you have no idea what the effect looks like until it has been printed. Some 3D effects didn't really work well.
- Projection was tricky. That meant quality control was a big issue.
- Film can weave, hop and jump – annoying in 2D but literally a big headache in 3D.


A stereoscopic camera from 1922

It's a fact that some movies went out with imperfections, as time and money ran out. Audiences didn't always enjoy the experience of watching stereo. Early stereo didn't really work as a business.

Digital Stereo post

Now let's skip forward to more recent developments. By the early 90s Digital VFX tools had become widely available. Then, DI tools appeared. In parallel, Digital capture and Digital projection have come along to help solve acquisition and especially display issues that film can cause.

So now, filmmakers have better tools and resources to head off problems and improve the quality of the final result – and many excellent stereo films have been and are being made. So, is making a 3D project now easy? Unfortunately it isn't. There are still many issues in post. You have all the day-to-day issues of conventional projects overlaid by the added demands of stereo workflow. In a nutshell, the single biggest problem is that you often can't see what you are actually doing as you are doing it. Let's break that statement down into each part of a typical post workflow.

Off-lining Stereo 3D

The first common problem is the offline. You can't 100% accurately off-line stereo projects on conventional offline systems. Here are some of the basic problems:

- As you are working at low res, typically mainly looking at one eye, you can't necessarily see low level artifacts that have affected one camera but not the other (dirt, lens flare and sensor or playback issues). These can be unsettling to the final full quality result. The answer is either to try to identifying them early for fixing before the finishing process, or have the tools available in the online session to fix them there and then.
- There can be camera sync issues between the eyes (for example a timecode 1-frame offset introduced during recording or transfer) which will give rise to a fault. The offline process ideally needs to identify any instances of that.
- There may be slight colorimetry differences between each camera 'eye' which don't get picked up during offline. So, as well as a creative overall grade, the colorist may need to do fix up work too.

As well as these problems, there are some more subtle issues with the offline:

- You can't judge stereo strength and convergence effects. Having shots 'jump out' at you during a sequence is very unsettling. Although convergence and strength can be altered during finishing by VFX tools, sometimes some re-cutting of a sequence may be preferable.
- You can't judge the rhythm of the project (3D feels better with longer slower shots). An offline editor who hasn't worked in stereo needs to learn the medium. Easy with those fast cuts, folks!
- When objects move off screen, one camera image goes off screen before its pair, causing a disturbing effect which the eye can be drawn to – away from the main area of interest.
- The project may need conventional 2D versions as well. This might actually be a wholly different cut.

That all means offlines are still necessary – but not necessarily definitive for the stereo finishing session. Typically, much more fixing needs to be done in the online finishing process than on a conventional project, so it is essential to have access to color, comprehensive FX and editorial tools during online.

Onlining Stereo 3D using conventional 2D systems

The next issue is setting up a suitable stereo online suite. This may be a special viewing suite, where elements made elsewhere are brought together and shown from a server or pair of servers via digital projection. Alternatively the room may be an existing VFX, editorial or color correction suite.

Depending on the stereo technique being used (shuttered, polarized, frequency shift etc.) some or all of the following need considering:

- Whatever projection system is used, eye synchronization is critical. Sync drift on the playout servers or in any breakout devices mean that you can't accurately judge if there is an issue with the footage. This needs careful checking before a session begins and if necessary re-checking during the session.
- Room seating needs careful thought and may need changing. The viewing screen will typically be further away than in a conventional room and the client seating needs to take account of viewing angles and height.
- The sound depth field is important. Some projects are now using 7.1 and this may need specialist line up.

The main issue with using conventional 2D systems plus servers is the iterative, non-interactive nature of the process. Typically each eye is worked on, and then the results fed to the servers. This means a fair amount of trial and error and guesswork. Many excellent stereo projects have been finished this way but it is very hard work.

Onlining Stereo 3D using Stereo 3D systems

Clearly what is needed are genuine stereoscopic post systems. That's why at IBC2007 Quantel launched award-winning stereoscopic versions of its existing Pablo and iQ systems plus Sid – a new dedicated stereoscopic product.

Stereo places unusual demands on post systems, so Pablo, iQ and Sid all share a new and unique software and hardware approach to working on stereo projects.

- FrameMagic disk management: stereo burns up at least twice the disk space of a conventional project and has twice the playback demands. In the Quantel approach FrameMagic is used so there is no copying of media when editing and no need to defrag or consolidate. Reliable stereo playback is guaranteed without "stuttering" and loss of eye synchronization. That eliminates potential quality control headaches.
- Genetic Engineering shared workflow: Working with a team of systems on a stereo project means moving or sharing at least twice the media of a conventional project. Pablo, iQ and Sid can use genetic Engineering to teamwork with each other or third-party Linux or Window Stereo software applications without creating a single unnecessary new frame of media and with none of the well known performance, copying and disk management issues of a SAN. That all saves time and money.
- MME: Manipulating stereo images eats up at least twice the rendering horsepower. Pablo, iQ and Sid all use Quantel's MME (multiple media engine) technology, which dramatically reduces or eliminates any time waiting for rendering to take place. That makes sessions much quicker.

So, with a smarter faster and potentially cheaper approach, stereo post suddenly looks a much less daunting prospect. However there's an even more important technique that Pablo, iQ and Sid use – whole frame processing. This means you can reliably work in true realtime without using proxies and without rendering so you can see exactly what you are doing, while you are doing it. Proxies might miss blemishes that subsequently prove to be an issue. Graphics cards can now display stereo but can get out of step resulting in temporary inverse stereo. There may also be 8-bit quality bottlenecks. Playback stuttering can happen. None of these are issues with the Quantel systems.

Finally, the most important requirement for stereo online is to work interactively, at full technical quality. In a nutshell you want to be able to see exactly what you are doing while you are doing it. As well as tough hardware demands, stereo also places unusual toolset demands. Because of the offline issues previously mentioned, much more needs fixing in online post. That means a stereo online or color correction system ideally needs any tool that might be needed to fix a last-minute problem – and those problems could need color, editing or effects fixes. The alternative is to have to use several machines, and worse still, copy or move data between them. Pablo iQ and Sid all have the complete range of tools that might be needed instantly available to the artist. That means problems can be easily fixed.

That's why as well as using conventional computing resources to process stereo, Pablo iQ and Sid also use special stereo imaging hardware that manipulates the whole composite stereo image in realtime, on the fly and without writing back to disk. That means convergence, stereo effect strength and framing can all be set instantly and played out instantly.

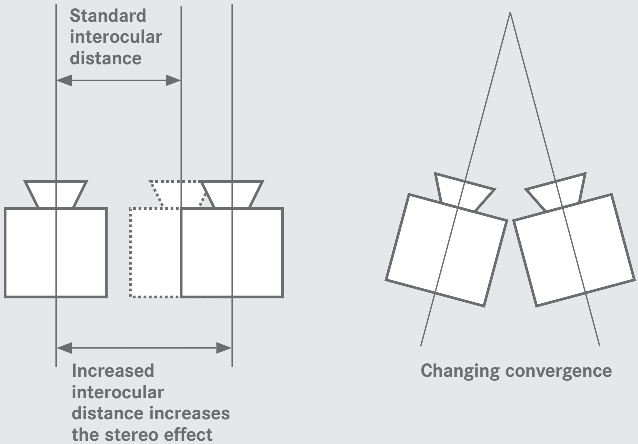
Conclusion

Of course, all of this is just a snapshot of where we are today, and as I said earlier, we are all still very much in a learning phase. Stereo 3D is the best thing that's happened to our industry in years. It's an opportunity for us all – manufacturers, broadcasters, post houses and of course the content producers. And it's fun!

Appendix

Stereoscopic images

Modern stereo 3D typically uses two digital cameras (mostly HD) linked together on a special rig to photograph the scene. The center of the camera lenses are about the normal distance between the eyes of an adult. However, to change the amount of the stereo effect this can be increased or decreased slightly.



Varying the distance between cameras (interocular distance) changes the amount of the effect. Varying the camera angles changes the area of interest (convergence point)

Also to change the area of interest between foreground or background objects it is possible to turn one or both cameras slightly. This has the effect of drawing the eye to different 'depth' points. Normal interocular distance is about 63.5mm (2.5 inches) however normal stereoscopic cameras start losing their 3D effect as the distance to the subject increases beyond 100 meters so some camera rigs can go up to 800mm or more.

Each camera records an image and because the viewing angles are different for the cameras, the images will be slightly different.

Human sight perception is a complex process. One eye is focused on one image and the other eye focuses on the other. The audience sees three virtual images instead of two real images. Because the middle virtual image is a combination of two real images, the brain does some very clever binocular processing and the audience sees the scene as if it were three dimensional.

Standards online

EBU offers many documents as free PDF downloads. Note that Technical Standards are designated N, Recommendations R, Statements D and Information I.
See: www.ebu.ch/en/technical/publications/index.php

SMPTE provides an index. 'Standards Scopes' provides a useful glance of what's available.
See: www.smpte.org/standards

ITU offers on-line purchasing. Most relevant items are listed at
www.itu.int/itudoc/itu-r/rec/bt/index.html

Some general browsing

www.quantel.com
Register for Digital Fact Book updates. Keep up to date with Quantel news and events, and access papers and comments.

www.dtg.org.uk
DTV in the UK and general news and information on digital television worldwide.

www.theiabm.org
Daily news and comment and useful industry reference.

www.postmagazine.com
On-line version of Post Magazine. All about post in the USA.

www.advanced-television.com
Daily news from Europe and beyond.

www.digitalbroadcasting.com
Includes editorial, news, product and professional centers.

www.broadcastengineering.com
Broadcast Engineering magazine with news, articles, archives and more.

www.dcinematoday.com
News, technology information and more from the Digital Cinema world.

Directory

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The Audio Engineering Society
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ETSI
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