

# JANET Video Technology Advisory Service

## Video Displays, Signals and Formats

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### Introduction

Personal computers and televisions are a familiar part of our lives. Both display images on their screens which appear quite similar, but in practice are generated in different ways. Videoconferencing uses a range of technologies, drawing as it does from the fields of video, computing and telecommunications. Display screens used during conferences may be showing video and / or PC screen images. This short paper aims to clarify these differences and hopefully dispel some of the confusion that exists between the two.

### The Video Signal Explained

Video started life as an analogue signal and remained so for over 50 years. However, digital television via satellite, cable and terrestrial transmission is now rapidly replacing analogue. Digital signals are less expensive to transmit because more information can be carried within a given bandwidth using digital multiplex and compression techniques. Digital signals also hold a significant advantage when it comes to video recording, editing and reproduction: whereas an analogue recording degrades with each generation of copying, the digital equivalent can nearly maintain the original quality after numerous copies. On initial analysis, picture quality is also superior to analogue with no apparent interference, ghosting or other problems. On closer inspection, however, errors can be detected, especially on rapidly moving pictures e.g. a football match.

### Analogue Video

Analogue video is commonly distributed as a composite signal, an almost universal connection between video cameras, VCR / DVD players and video monitors. When superimposed on a radio frequency carrier it forms the aerial signal transmitted to homes. It is also the most usual input connection found on a videoconference picture monitor. This and other signal types are described below:

#### **The composite signal**

The composite signal is composed of three parts: the black and white information (Luminance), the colour information (Chrominance) and the synchronisation (Synch) signals which ensure that the displayed pictures stay in close time synchrony with the transmission

source. A problem with composite signals is that the three elements have to be coded to enable them to combine, but in the picture monitor these have to be decoded in order to display an image. These coding / decoding processes introduce unwanted noise and distortion. Three different coding systems are used worldwide. These systems – PAL, NTSC and SECAM – are all mutually incompatible. The NTSC (the National Television Standards Committee) system is used in North and South America and Japan. SECAM (SEquentiel Couleur Avec Memoire) is used in France and Eastern Europe, and PAL (Phase Alternating Line) is used in the UK and the rest of Europe.

### **S-Video / YC**

To reduce coding / decoding distortion the TV signal can be transmitted as an S-Video or YC signal. S-Video has two separate parts, Luminance (Y) and Chrominance (C), and so requires two separate connection channels between equipment in the chain. This involves less signal processing (decoding) in the picture monitor, which means less noise / distortion and thus a better picture.

### **Alternatives**

To reduce decoding noise even further the TV information may be transmitted as three signals, with a luminance channel (Y) and two colour component or colour difference channels, Red-Y (R-Y) and Blue-Y (B-Y). This minimises processing in the display monitor but requires three connection paths. An alternative method transmits Red (R), Green (G) and Blue (B), as separate components.

### **SCART**

The popular SCART interface includes three separate R G B channels together with composite and stereo sound signals, with the connected devices choosing the most appropriate video connection.

## **Digital Video Formats**

Analogue video signals degrade when material is recorded or distributed. To overcome this, digital signals are now used throughout broadcasting. Another important advantage of digital signals is that massive compression is possible.

### **CCIR-601 / 4:2:2**

CCIR-601 was one of the first high quality digital standards to be introduced. It is also known as 4:2:2 or Y Cr Cb. It comprises Luminance (Y) and two Chrominance components (Cr and Cb) but as it requires a very wide bandwidth for transmission (around 166Mbit/s), it is rarely found outside broadcast studio environments.

### **4:2:0**

To reduce the required bandwidth, and thus cost, other formats were developed, including 4:2:0. This has the same picture rate and luminance resolution as 4:2:2 but a reduced colour resolution, which is imperceptible to human eyes, as the human eye is much more sensitive to the luminance signal than to the chrominance signal. It is important as it forms the basis for the MPEG-2 (a video compression standard) form of coding used extensively for distributing digital television including SKY and Freeview. More information on MPEG-2 coding is available in *Videoconferencing Standards* (<http://www.video.ja.net/stan/>).

### **SIF and CIF**

For less demanding applications SIF (Source Intermediate Format) was introduced. This has reduced frame rate and chrominance resolutions. An even lower quality format – CIF (Common Intermediate Format) which is a cross between the US and UK SIF formats – is used in videoconferencing. Other formats found in videoconferencing include the Quarter

(QCIF), 4xCIF and 16CIF (for still images). QCIF has the lowest resolution and frame rate and is the base line format used within IP and ISDN conferencing for compatibility. A big advantage of CIF and its derivatives is that they are independent of origination television standards (PAL, NTSC etc.). This allows communication from the UK to the USA without standards conversion.

The main digital formats are summarised below.

**Table1. The Main Digital Video Formats**

		4:2:2(UK) 625 / 50	4:2:0(UK) 625 / 50	SIF(UK) 625 / 0	SIF(USA) 525 / 60	CIF	QCIF	4CI	16CIF
Luminance Resolution (H in pixels V in lines)	H	720	720	360	360	360	180	720	1440
	V	576	576	288	240	288	144	576	1152
Chrominance Resolution (H in pixels V in lines)	H	360	360	180	180	180	90	360	720
	V	576	288	144	120	144	72	288	576
Picture Rate		50	50	25	30	30	15 / 7.5	Still frame	Still frame

## Display Devices

### The Video Display

Television and video images are designed to be viewed on a fairly large screen across a room. A typical domestic set will have a picture tube size of around 26 inches across its diagonal. Much larger Plasma Panel and LCDs (Liquid Crystal Displays) with 32, 42 and 50 inch screens have become commonplace over the last few years. Within a lecture theatre a very large image, typically of 12 foot diagonal, is provided by a projection system. The broadcasters have established that a comfortable viewing distance for images is around five to six times the diagonal so for a typical 26 inch screen this equates to about 10-12 foot distance.

### Computer Displays

The VDU (Visual Display Unit) is used to view computer images and has a relatively small screen as it is designed to be viewed fairly closely. Either CRT (Cathode Ray Tubes) or active matrix devices such as LCD screens are used. Screen flicker and screen resolution are important considerations with a VDU. The close viewing distance dictates a high picture refresh rate and a fine line structure whereas a domestic television viewed at a much greater distance is not nearly so demanding. Computer images are digital in nature and derived from a matrix of tiny blocks or pixels. Each pixel is addressed individually to define its colour and brightness. With an active matrix device the screen pixels can be switched to correspond exactly to this computer generated image. Horizontal resolution is defined as the number of pixels per picture width, and vertical resolution as the number of pixels per picture height. With CRT displays, an analogue scanning process is employed. The number of horizontal scanned lines per picture varies from 525-2000 and the picture repetition or refresh rate

from 75-150 images per second. With VDUs the number of active lines in the picture also defines the vertical resolution, as each scanned line is arranged to overlay a line of pixels.

## **Analogue display devices**

Until relatively recently PC display devices invariably used CRTs which, as analogue devices, required an analogue signal to operate. This meant that the digital signals which generate the elements of a computer display had to be converted (digital to analogue) within the PC before being routed to the CRT. The format used was known as VGA (Video Graphics Array).

### **VGA, SVGA, and SXGA**

VGA is comprised of five separate signals: Red, Green and Blue which define the picture content, together with vertical and horizontal synchronising signals. VGA has a resolution of 640 (picture width) x 480 (picture height) pixels. Developments of VGA to give increased resolution and refresh rate are SVGA (Super VGA) 800 x 600 pixels and SXGA (Super eXtended Graphics Array) 1280 x 1024 pixels. Direct comparison of the picture quality of television and VDU displays is not straightforward because TV images are produced by a scanning process whereas PC images are switched in discrete blocks or pixels. Generally, however, a VGA image corresponds fairly closely in quality to a standard PAL broadcast signal. SVGA and SXGA are, however, of higher quality.

## **Digital Display Devices**

As a result of their compactness and low energy requirements, LCDs have made the laptop a reality, and they are now tending to replace CRTs in desktop PCs. They are inherently digital in operation, but due to the universal VGA method of connection, VGA and its derivatives have generally been used to connect LCD screens to the PC. This involved not only coding of the digital elements of the display in the PC to the analogue VGA format but a decoding process in the LCD device to convert VGA back to digital. This extensive and unnecessary signal processing introduced unwanted signal noise, distortion and complexity. To overcome this limitation digital interfaces were developed that enabled direct digital connection between a PC and its VDU. The main interface now used is known as DVI (Digital Video Interface).

## **Development of the Digital Video Interface**

The first digital interface was developed by VESA (Video Electronics Standards Association) in 1997. Known as the D&P interface, it used TMDS (Transmission-Minimised Differential Signalling) digital signalling and included USB, Fire-wire and analogue VGA channels but was unpopular due to its complexity. A simpler derivative developed by the DFP (Digital Flat Panel) group dropped the VGA, USB and Fire-wire streams but was limited by a top resolution of 1280 x 1024 pixels. The DDWG (Digital Display Working Group), formed by manufacturers, designed the DVI standard interface. This is now becoming the de-facto standard, not only for LCD monitor connection, but also between other equipment such as DVD players and high definition viewing screens. DVI has a resolution up to 1920 x 1080 pixels.

The DVI connection has three versions:

- DVI-D that conveys digital signals only
- DVI-A that transfers only analogue signals
- DVI-I (Integrated) that combines digital and analogue in a single connector.

## Displays within Videoconferencing

Room based systems generally use large picture and / or data monitors while lecture theatres will have projection systems. The CODEC (coder / decoder) will connect to these monitors either through a composite, an S-Video interface, or a SCART connector. Data displays for local and remote sites will normally use a VGA or DVI connection to the display device. Some monitors and most data projectors can handle both video and data signals.

It is possible to display data signals on a normal television monitor, but the signals have to be converted to the required format. This is achieved by a scan converter. Due to generally higher quality of data signals this conversion process to video (PAL in the UK) inevitably involves some degradation. Scan conversion can be useful for introducing the images from a document viewer or a laptop into a simple videoconference.

## References and Further Information

Digital Television by H Benoit, Published by Arnold ISBN 0-340-69190-5

The VGA standard:

<http://www.webopedia.com/TERM/V/VGA.html>

Plug and Display (P&D) interface:

<http://www.interfacebus.com/>

The Digital Video Interface (DVI):

1. [http://www.datapro.net/techinfo/dvi\\_info.html#Page01](http://www.datapro.net/techinfo/dvi_info.html#Page01)
2. NEC Mitsubishi: <http://www.nec-mitsubishi.com/>

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