System Planning

& Design Resource

Design Guide

Switchers

Video Walls

Multiviewers

Codecs

KVM

RGB SPECTRUM®

To Our Valued Customers and Partners,

We're here to help you select the finest equipment that solves your challenges, in an elegant, intuitive, and purpose-built manner. Since 1987, we have been designing and manufacturing innovative solutions for the display, recording and transmission of computer and video signals. With advanced capabilities, proven reliability, and flexible user interfaces, our products are preferred by discriminating customers in commercial, military, industrial, medical, security, energy, and educational markets.

In creating this guide, our primary goal is to help simplify the process of choosing the right product for each system. The introductory section includes an overview of current and emerging audiovisual technologies, followed by primers on Networked AV and 4K video technologies, a directory of RGB Spectrum products, case studies, and specifications for all RGB Spectrum products, sample system diagrams, and finally, a glossary of key terms and concepts.

RGB Spectrum's products work together to provide a key part of a system solution — the AV core around which the rest is designed. The case studies illustrate methods to configure both simple and advanced systems. You can expand upon these to meet the requirements of your customers.

We are happy to assist our readers to develop better, more effective, and more profitable AV solutions.

If you need more assistance, our Design Services team is at the ready to help guide you through the process of determining the optimal RGB Spectrum equipment for your project.

Sincerely,

Bob Marcus

Founder and CEO
RGB Spectrum

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TECHNOLOGY TUTORIAL

Effective video resource management requires the integration of many different underlying technologies working together to provide users with the best possible experience of a given application. Many of these technologies have evolved from those used in the early days of television broadcasting. Others, such as the compression methods used for streaming video over networks, are relatively new and continually evolving.

The following sections provide a detailed overview of some basic technologies related to the processing and transmission of graphics and video, and offer a context for understanding the unique benefits offered by RGB Spectrum's range of products.

VIDEO SIGNAL TYPES

ANALOG

A color analog video signal contains information about luminance (Y) and chrominance (C). When these parameters are combined into one channel, it is called composite video. Composite, which used to be the most common type of video signal in consumer video equipment, is typically delivered over a single cable with a yellow RCA-type connector. Analog video may also be carried over separate wires in a cable, i.e. two channel S-Video (Y/C) and three, four and five channel component video formats. S-Video produces a slightly better image than composite, but component video provides the best possible analog image quality.

The most common type of component signal separates a video signal into three components. For the analog output of many devices, the three components are red, green, and blue signals. On computers and display devices, RGB signals are most often carried on 15-pin VGA-type connectors. Component can also represent the video signal as one luminance signal (Y) and two color difference signals (often called Pb and Pr). On some video devices, component YPbPr signals are carried by cables that terminate with three RCA or BNC connectors. The composite sync signal is carried on the luminance (Y) signal.

Audiovisual systems typically consist of a combination of analog and digital signals, and many legacy systems have only analog outputs. For this reason, most of RGB Spectrum's products include the option of analog input cards, which enable analog signals to be processed and distributed.

DIGITAL

Digital video consists of a series of bitmap digital images (or frames) displayed in rapid succession at a constant rate. The rate at which these frames are displayed conveys the sense of motion, and is measured in frames per second (FPS), or cycles per second (Hz). The minimum frame rate to achieve the illusion of motion is about 24 frames per second.

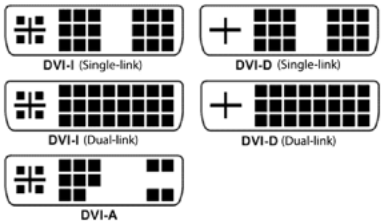
Each frame comprises a matrix of picture elements (or pixels). The color of a pixel is represented by a fixed number of bits of data. The more bits, the more subtle color variations can be reproduced. This is called the color depth of the video. Computers typically store and transmit color with 8 bits of data for each of the three R, G, and B components; this is known as 24-bit color, also called True Color. 8-bit color depth can produce 16.78 million colors. If more colors are needed, bit depths of 30 bits (1.073 billion colors), 36 bits (68.71 billion colors), and 48 bits (281.5 trillion colors) are also possible. A wider color range will result in color rendering that is more realistic.

SIGNAL INTERFACES

DVI

Digital Visual Interface (DVI) was developed in 1999 as a convenient interface for the transfer of uncompressed digital video signals. The DVI specification also provides optional compatibility with the VGA interface for analog video.

A DVI connector may have up to 29 pins that transmit signals, although not all pins are used in all cases. There are five different DVI connectors:



- DVI-A: analog only; content is found on the four-pin group that is separate from the main pin group.
- DVI-D (single-link & dual-link): digital only; the four-pin

group is only sometimes present, but no content is carried on it.

- DVI-I single-link: analog and digital; both pin groups active.
- DVI-I dual-link: digital with or without analog; two DVI digital links are provided to support high resolutions.

Although DVI was originally developed as a computer interface, became a common connector on many professional electronic devices as well. As outlined above, there are two types of links in the DVI specification to support different resolution requirements, namely single-link and dual-link. Single-link connections can support a maximum pixel rate of 165 MHz for resolutions up to 1920x1200 and 24-bit color. Dual-link connections can support a maximum pixel rate of 330 MHz, and resolutions up to 3840x2400 although the more common resolution is 2560x1600. Dual-link does not mean "dual cables"; both types of link use a single physical DVI connector. The difference lies primarily in the pin count, configuration, and maximum resolutions supported.

Industry Problem: Graphics cards and other high resolution sources output dual-link DVI signals but many video processors do not handle these high-speed interfaces.

RGB Spectrum Solution: RGB Spectrum products incorporate dual-link DVI interfaces to provide support for the highest resolution signals up to 4K/Ultra HD.

HDMI

High Definition Multimedia Interface (HDMI) is an evolution of DVI developed in 2002 specifically for consumer electronics devices. Like DVI, HDMI uses Transition Minimized Differential Signaling (TMDS), a high-speed serial link developed by Silicon Image. However, they differ in significant ways:

- HDMI is not compatible with analog VGA signals.
- DVI is limited to the RGB color space. HDMI supports RGB, but also supports YCbCr (see "Color Models" on page 7), a digital color space that is widely used in the broadcast video industry.
- HDMI can carry digital audio signals, DVI cannot.
- An HDMI connector is much smaller than a DVI connector, and can be less robust in professional/commercial applications.

There are five different types of HDMI connectors defined by the standard. However, the most common connectors used in AV installations are the Standard (Type A) and Mini (Type C) connectors.

DISPLAYPORT

DisplayPort, first approved in 2006, is the newest digital video interface. Developed by the Video Electronics Standards Association (VESA), it has started to replace older standards like DVI and VGA. Unlike DVI and HDMI, which uses TMDS, DisplayPort relies on packetized data transmission, which allows the interface to pass more data (and achieve higher resolutions) on fewer pins. Like HDMI, it can be used to transmit both video and audio. DisplayPort has become a common port on graphics cards, computers, and displays. Apple® adopted a smaller version in 2008, called Mini DisplayPort (or mDP), which is currently available on many Apple and other products. Support for stereo 3D video has also been incorporated into the current standard.

One of the key physical features of the DisplayPort interface is a locking connector that is physically smaller than a DVI connector. Also, DisplayPort uses a single clock frequency, which lowers the cost of transmitters and receivers. DisplayPort HBR3 mode in version 1.3 can support resolutions up to 4K UHD (3840x2160) at 120Hz. It can also directly transmit HDMI, DVI or VGA signals using a simple dongle adapter. While full-bandwidth transmission is limited to about 3 meters of cable length, information can be transmitted up to 33 meters using active cables.

The following chart summarizes the maximum resolutions supported by DVI, different versions of HDMI and DisplayPort interfaces:

Maximum Resolution Capabilities

DVI	1920x1200 p60
Dual-link DVI	3840x2160 p30
HDMI version 1.4	3840x2160 p30
HDMI version 2.0	3840x2160 p60
DisplayPort v1.3	3840x2160 p120
DisplayPort v1.4	7680x4320 p30

SDI / HD-SDI / 3G-SDI

Serial Digital Interface (SDI) is a family of video interfaces defined by the Society of Motion Picture and Television Engineers (SMPTE) in 1993. Its primary applications are in the professional broadcast television industries, although it is also commonly used in live-event production, medical imaging, and other high-end applications. The original SMPTE 259 (SDI) is a serial, one-way protocol that provides data rates of up to 360 Mbps.

Other SMPTE SDI standards with higher bitrates have been introduced and are known as HD-SDI, 3G-SDI, 6G-SDI, and 12G-SDI. The latest standard, SMPTE ST-2083 (24G-SDI) is in development with a proposed bitrate as high as 24 Gbps. All versions of SDI use one or more coaxial cables with BNC connectors and a nominal impedance of 75 ohms.

HDBaseT

HDBaseT is the latest innovation in connectivity technology, and it has been adopted by many consumer and professional video electronics manufacturers and installers. The first specifications were finalized in June 2010 with the goal of establishing a new global HD digital connectivity standard.

HDBaseT is capable of transmitting uncompressed UHD digital video, audio, 100BaseT Ethernet, USB, up to 100 watts of power, and control signals (RS232, IR) through a single 100m/328ft CAT-6 cable with RJ45 connectors (common network cable). Video is passed through from an HDMI chipset, so it supports the same resolutions as HDMI 1.4. HDBaseT also supports 4K video at 30 fps, new 3D formats, Consumer Electronics Control (CEC) and Display Data Channel (DDC) standards.

FIBER INTERFACES

Fiber optic systems transmit information using pulses of light traveling through optical fiber cables. Fiber optic transmission technology offers a number of benefits over other transmission media (i.e. copper, CAT-6, etc):

- Long-distance transmission — Depending on the type of cable used, information can be transmitted anywhere from several hundred meters to many kilometers without signal degradation.
- Secure transmission — Signals traveling over fiber optic cable do not generate electro-magnetic fields. For this reason, signals can't be detected externally, which makes fiber transmission more secure than transmission over copper cables.
- Logistics — Fiber optic cables are thin and lightweight which simplifies installations; multiple channels can be pulled through a small-diameter conduit.

DIGITAL VIDEO

Digital technologies have revolutionized the way we work with both audio and video signals. However, representing information as groups of binary numbers requires an enormous amount of computing power, specifically memory capacity and processing capability. These requirements become especially challenging when audio and video signals are involved, because massive amounts of data are necessary to translate the characteristics of sound and light into bits.

Digital sound and video have created entirely new industries for both consumer and professional/commercial applications. One of the most important differences between these two types of applications is that professional/commercial users don't just use content like consumers do; rather, they often need to work with, manipulate, and combine this content with other sources. Information from any number of content sources frequently must be shared with co-workers who may be located in the same room or in remote locations around the globe. Digital technologies and networks have made these tasks significantly more effective than was ever possible in the analog domain.

The rise of digital technology has introduced a new set of challenges, primarily related to the vast amount of data that is required to represent digital video. For example, an image size of 1920x1080 pixels at 24 bit color depth can translate to about 6 MB per frame. At a frame rate of 60 fps, just one second of this video results in 3.6 GB of data, which is impractical for most current networks and storage systems. This example illustrates why video compression technology is often necessary when working with digital signals in these contexts.

COMPRESSION

Video compression is a process that reduces and removes redundant video information so that a digital video file/stream can be sent across a network and stored more efficiently. An encoding algorithm is applied to the source video to create a compressed stream that is ready for transmission, recording, or storage. To decode (play) the compressed stream, an inverse algorithm is applied. The time it takes to compress, send, decompress and ultimately display a stream is known as latency.

A video codec (encoder/decoder) employs a pair of algorithms that work together. The process for encoding and decoding must be matched; video content that is compressed using one standard cannot be decompressed with a different standard. Different video compression standards utilize different methods of reducing data, and hence, results may differ in bit rate (i.e. bandwidth), latency, and image quality.

Types of compression are often categorized by the amount of data that's maintained through the stages of processing. "Lossless" refers to a compression method in which there is no loss of data during the transmission of a video signal from source to display. The displayed image is identical to the original source image. "Visually lossless" means that the displayed image will appear identical to the original image, even if some data may actually have been lost during compression. "Lossy" compression usually involves some loss of data during the data-reduction process, but noticeable quality degradation may or may not be apparent.

CONTENT PROTECTION

One issue that impacts both commercial users and consumers alike is how to protect and display copyrighted material. Because digital content can be copied and played back with a quality level equal to the original source, it's possible to make copies to sell or re-broadcast this content without providing compensation to the original source providers.

This problem is of serious concern to content creators, especially in the motion picture industry, who believe that unregulated copying and distribution of high-value content creates the potential for significant financial damage to their industry.

In response to this issue, the industry has implemented content protection schemes to safeguard a content creator's right to receive compensation. These measures are referred to as Digital Rights Management (DRM). DRM applies to motion picture films, television broadcasts, and other types of creative content that can be delivered in a digital format over the air or on networks. The most common content protection technique used is High-Bandwidth Digital Content Protection (HDCP).

HDCP is an encryption protocol used with digital interfaces including HDMI, DVI, DisplayPort, HDBaseT, and fiber. The HDCP specification was developed by Intel, and has broad industry support from the major players in the digital entertainment value chain, including The Walt Disney Company, Warner Bros., and Sony Pictures Entertainment. Nearly 800 companies license the technology, including RGB Spectrum and most other video product manufacturers.

The HDCP content protection system includes three elements:

1. Authentication of HDCP-compliant receivers to their immediate upstream connection (an HDCP transmitter). The authentication protocol involves a "key exchange" process and is the mechanism through which the HDCP transmitter verifies that a given HDCP receiver is licensed to receive the protected content.

2. Encryption of audiovisual content over the HDCP-protected interfaces between HDCP transmitters and their downstream HDCP receivers.

3. Revocation of HDCP receivers that are determined to be invalid, or non-compliant. This is a feature that is built into the HDCP specification; in reality, however, it is not clear that revocation lists are being updated by device manufacturers.

THE CHALLENGES OF HDCP

HDCP was developed with consumer electronics in mind. In these general applications, a single source device is either connected directly to a display device, or connected to an AV receiver (called a "repeater" in HDCP terminology), which is then connected to a display device. The HDCP version 1.0 specification allows for the connection of up to 128 devices, and a maximum of seven repeaters. However, depending on each device manufacturer's specific implementation of HDCP, the true maximum number of supported devices might be far fewer than this.

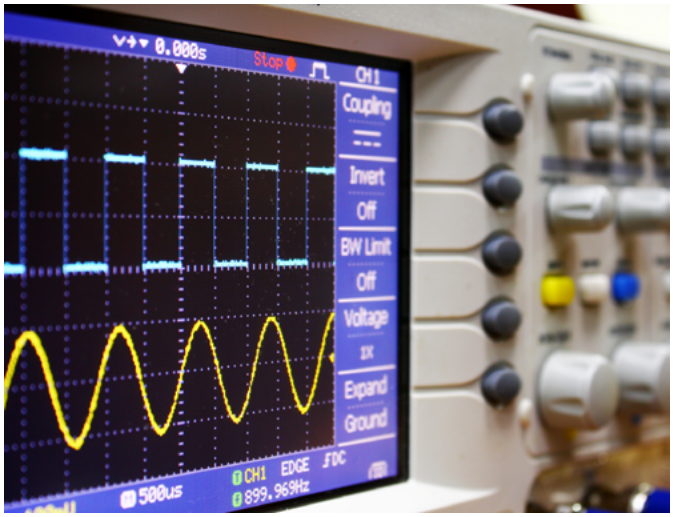
The most recent version of HDCP, version 2.2, supports a smaller number of devices but also covers protection of streaming content. There is some backwards compatibility issues with v2 and v1 devices. There is also a variant of v2.2 called v2.2 Professional that removes the device limits but will require major modifications by equipment manufacturers before it can be used in the marketplace.

In contrast to consumer applications, professional and commercial AV applications often require the use of many more devices and complex signal routing and distribution capabilities that can easily exceed the specification limits. Also, if any device in the system uses HDCP content (like a Blu-ray disc player or set-top box) then all system devices must be HDCP-compliant. If any device in the system is determined to be "non-compliant", then an HDCP source may stop transmitting signals to all displays.

This has particular relevance if we look at video walls, which display multiple signals simultaneously on an array of monitors or projector screens. To effectively display protected content, it is important to choose an HDCP-compliant wall processor, like RGB Spectrum's MediaWall® V or Galileo™ Display Processor. If the processor itself is not HDCP-compliant, then any HDCP-protected video inputs in the system may not display properly on a video wall.

For system designers, therefore, it's important to consider whether an end-user will need to use copy-protected content at any time in the system. If they will, then HDCP compliance becomes a significant design consideration.

SIGNAL INTEGRITY



The process of transmitting video signals, whether analog or digital, over a length of cable involves a certain amount of signal degradation which can affect the integrity and/or clarity of a transmitted signal. The degree of degradation is primarily dependent on two main factors: 1) the nature of the signal and 2) cable quality and length.

Analog video signals degrade in a different manner than digital signals. As cable length increases, analog signals will degrade gradually, losing detail, and resulting in "fuzzy" or "grainy" images. Digital signals, however, do not degrade in a linear fashion, and the impact is likely to be more immediately visible (i.e. affecting specific blocks or chunks of an image). In fact, when dealing with digital signal degradation, it's possible for a signal to degrade so much

that the result is a sudden and total loss of image.

For the consumer applications that common digital interfaces (HDMI, DVI, DisplayPort) were designed for, this is not a major problem; transmission distances in these contexts rarely exceed several meters. However, many commercial applications require greater distances between devices than standard cables can accommodate with acceptable signal quality.

For both analog and digital signals, there are two main electrical characteristics of cabling that need to be considered: resistance and capacitance. Resistance refers to the forces that oppose the passage of a signal through a conductor, while capacitance can be defined as the amount of charge that a cable can store. Both of these characteristics negatively impact signal integrity and their effects intensify as cable length increases. Using a higher quality cable with lower resistance and capacitance can extend the usable length before signal integrity is impacted. For this reason, we always recommend that you use the best quality of cables possible in audiovisual installations.

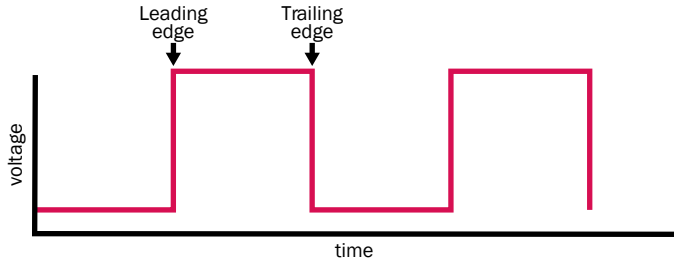
The critical factor for analog signal integrity is the "shape" of the signal as viewed on an oscilloscope. For digital signals, however, the key factor is bit error rate. The transmission bit error rate is the number of failed bits relative to the total number of transmitted bits. A bit error occurs when the receiver cannot properly distinguish between low and high voltage levels. Bit errors in video are visible until the point of image failure. The typical warning signs of bit errors are sparkles in the image, missing lines, or streaking, and these may ultimately lead to a complete loss of image. In video transmission and processing applications, these are often referred to as "artifacts" that negatively impact the visual quality of the transmitted signal.

Some of the factors that affect the bit error rate include:

Rise Time/Fall Time – the amount of time it takes for a signal to transition from low to high (rise time — the leading edge of the signal), and from high to low (fall time — the trailing edge).

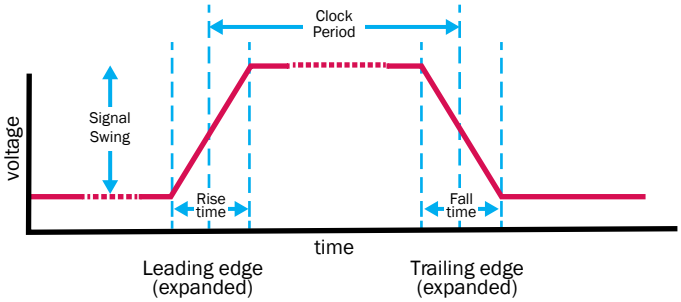
Signal Swing – the voltage difference between the low state and the high state.

Clock Period – the amount of time between transitions.



Identifying Leading and Trailing Edges

Even though the signals used to represent digital information are depicted as waveforms that have only two discrete states, the transition between voltage levels representing "on" and "off" is not instantaneous. A specific amount of time is required for each transition. These finite time periods are referred to as the rise time and the fall time respectively.



Expanded Leading and Trailing Edges

The figure above illustrates an expanded view of the rise and fall time of a digital signal. Rise time/fall time, signal swing, and the clock period are all affected by cable length. Cables that are too long can interfere with proper timing, which can destroy signal integrity.

Signal processing (such as cable equalization) on the receiver's input can help restore the digital signal and minimize bit errors. Cable equalization is a common and effective way to restore the voltage level and rise/fall time of a digital signal.

Some basic guidelines for minimizing bit errors and maximizing signal integrity include:

1. Use only high-quality cables and connectors.
2. Minimize cable lengths.
3. Avoid extending cables with adapters or "gender changers."
4. Use cable equalization and/or re-clocking circuitry when possible.

RGB Spectrum's video processing and switching systems are designed to protect signal integrity, with built-in cable equalization that preserves signal clarity over longer distances. We also offer a full range of fiber, HDBaseT and IP extenders that can accommodate resolutions up to 4K.

DISPLAY PROCESSING

A BRIEF HISTORY OF EDID MANAGEMENT

With the availability of a wide range of signal types, display devices and processing products, it becomes difficult for video system users to optimize the output timings of source devices for all of the different kinds of display devices to which they can connect. Fortunately, the Video Electronics Standards Association (VESA) recognized this potential problem long before the proliferation of digital display devices. In 1994, VESA introduced a standard by defining an interface through which data about the display device

could be communicated to source devices.

This interface, the Display Data Channel (DDC), was first implemented as part of the DVI standard, and later retrofitted to the SVGA standard, designed to work with VGA cables with blue connector shells. The data transmitted on the DDC (and defined within the DDC standard) is known as Extended Display Identification Data (EDID). DDC and EDID have been incorporated into digital display standards such as DVI, HDMI, and DisplayPort.

EDID OVERVIEW

When a source is first connected to a display, a "hot plug" event takes place to let the source know that a display or other "sink" device has been connected. In this, a source device generates a low voltage signal which is sent to, and returned by, a display device. Upon detection of the hot plug event, the source device issues a DDC "EDID Read" command to the destination device. In response, the display transmits its EDID file to the source device. This EDID file contains information about the display's preferred (native) resolution, as well as information about other supported resolutions, color space, bit depth, and the audio formats it supports.

Additional types of information that can be conveyed through the DDC include:

- Manufacturer name, product serial number, and date of manufacture
- Product type
- Timings supported by the display
- Display size
- Color space conversion
- Pixel mapping data

For simple systems consisting of a single source and single display device, the transfer of EDID information is straightforward and works quite well. But for larger systems with multiple sources, displays, switchers and signal processors of various types in the signal chain, EDID transmission can become problematic, because the sources may receive conflicting information from various "sink" devices (i.e. different video displays). In other cases, a source may not be able to accurately read EDID information causing a disruption in the display. Thus, effective EDID management has become a critical issue for commercial, professional and industrial AV installations.

Industry Problem: Routing a source between displays of different native resolutions can cause the source to switch resolutions every time it is routed, leading to disruption in the video output.

RGB Spectrum Solution: RGB Spectrum products offer Total EDID Manager™, a solution that enables our input cards to provide consistent EDIDs to source devices for seamless image display, regardless of where they are routed.

RGB SPECTRUM'S EDID MANAGEMENT SYSTEM: SAMPLE USE CASES

To better understand the benefits of an EDID management system, let's consider some typical use cases:

1. The sources input to your display processor look best at a higher resolution than the native resolution of the displays connected to the processor's outputs. With an EDID management system, you can choose a high native resolution EDID, which is suitable for your source devices, from the EDID list and use that as a fixed EDID at the input. In this way, you can display full-resolution windows spread across multiple displays.
2. Your processor is usually connected to a wall of displays with a fixed resolution, but you would like to test and develop material offline while connected to some smaller multi-sync monitors with a different native resolution. You can capture the EDID of one of your wall displays, and use this as the emulated EDID of the processor's output. This will allow your tests and final presentation to have the same pixel dimensions as the original wall displays.
3. You have a diverse set of inputs, each with different pixel dimensions and aspect ratios, which were originally displayed on monitors of different sizes and shapes. You would like to display each source as a window at its original pixel dimensions on a video wall or Ultra High Definition (UHD) display. To accomplish this, you can capture the EDID from each of the original monitors, and set these as fixed EDIDs at each of the inputs.

COLOR PERCEPTION

Seeing color is a perceptual experience that happens when light is received by the human retina. The retina is sensitive to light primarily in the region of 400 to 700 nanometers in wavelength. There are three types of color-sensitive photoreceptive "cone" cells in the retina which each respond to different sub-bands within the 400 to 700 nm range. These correspond roughly to blue (peaking around 445 nm), green (peaking around 535 nm), and red (peaking around 575 nm). For this reason, red, green, and blue are considered the primary colors for light perception and video processing/display applications.

COLOR MODELS

A virtually infinite range of colors can be defined using the parameters of one or more color models. The most common and well-known color model is RGB, in which colors are broken down into various combinations of red, green, and blue. RGB is the color model for most computer monitors and video systems that use 24-bit color depth, which means that each pixel of each of the three colors is comprised of eight bits of data. This data is a numerical representation of the "brightness" of each color. Because there are 2^8 or 256 possible values for 8 bits, 24-bit color depth provides 256 discrete brightness levels for each color (R, G, or B), resulting in 16.7 million (256 x 256 x 256) color variations.

Although the RGB model is the most common, there are several other color models as well.

YUV is a color model that takes into account human visual perception and reduces the bandwidth for chrominance (or color) components. The Y in YUV refers to "luma" (brightness, or lightness). U and V provide color information and are "color difference" signals of blue minus luma (B-Y) and red minus luma (R-Y).

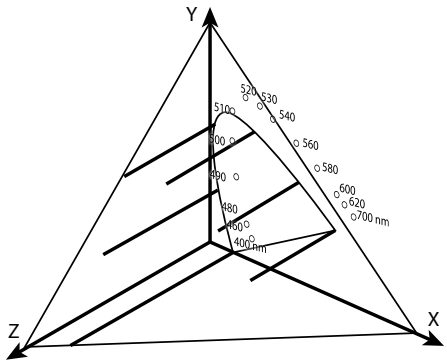
The YPbPr color model is used in analog component video and its digital version, YCbCr, is used in digital video. Both are more or less derived from YUV, and are sometimes called Y' (Y "prime") U V, where Y' represents the gamma-corrected luminance signal.

HSV (hue, saturation, value) — also known as HSB (hue, saturation, brightness) — is often used by artists because they find it more intuitive to think about a color in terms of hue and saturation rather than additive or subtractive color components. HSV is a transformation of an RGB color space, but its components and colorimetry are similar to the RGB color space from which it is derived.

HSL (hue, saturation, lightness/luminance) – also known as HLS – is quite similar to HSV, with "lightness" replacing "brightness." The difference is that the brightness of a pure color is equal to the brightness of white, while the lightness of a pure color is equal to the lightness of a medium gray.

COLOR SPACES

In 1931, the Commission International de L'Eclairage (CIE) developed a method for systematically measuring color in relation to the wavelengths they contain. This system became known as the CIE color model. The X and Y coordinates represent hue and saturation, while Z is the wavelength. Z coordinates are projected onto the XY plane, producing a parabolic curve that defines the color space. The perimeter edge of the parabola identifies wavelengths of visible light in nanometers. The CIE model allows you to specify ranges of colors, also known as a "gamut," that can be produced by a particular light source. All of the possible colors that a light source can produce fall within a triangle defined by the red, green, and blue color limits.

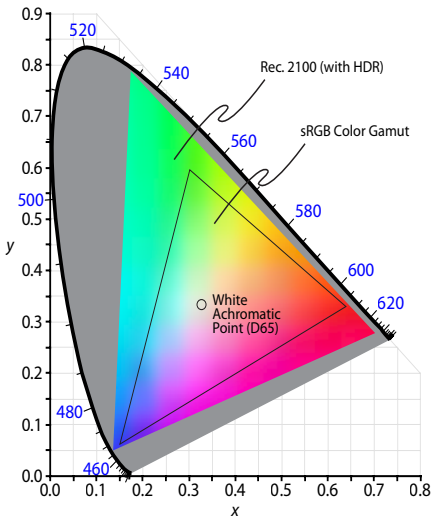


Color wavelengths (Z) are projected onto the XY plane to generate the Color Space Chromaticity Diagram of visible colors.

Color space conversion is the translation of the representation of a color from one basis to another, i.e. from RGB to YUV or vice versa. This can be important when a transmitting device (or source) defines color using one color model, and the receiving device (or display) uses a different color model to define colors. If the source device has a larger color gamut than the display device, some of those colors will be outside of the display's color space. These out-of-gamut colors are called a "gamut mismatch." Color space conversion corrects for gamut mismatch and allows the display to show an image that is as close as possible to the original image supplied by the source.

Industry Problem: Mismatches between source and display color spaces can result in images turning pink or other color imbalances.

RGB Spectrum Solution: RGB Spectrum's products offer convenient color space conversion to correct for source display mismatches to ensure that colors are displayed accurately.

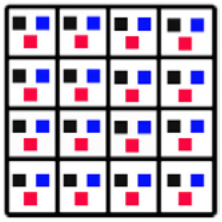


The CIE 1931 Color Space Chromaticity Diagram displays all possible color combinations.

WHY DOES COLOR PROCESSING MATTER?

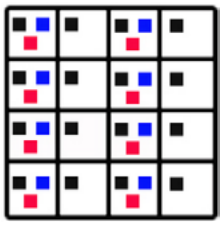
Human vision perceives changes in brightness (luminance or “Y” value) much more so than variations in color values. For this reason, some color information can be removed from signals to reduce the bandwidth needed to process and transmit graphics or video signals, while still maintaining the visible integrity of the color. This is usually accomplished by “subsampling” color values, and then using surrounding values to recreate the missing color values.

Color processing within the video processing space is often described in terms of color subsampling ratios: 4:4:4, 4:2:2, 4:1:1, 4:2:0, etc. The first number refers to the number of luminance values provided in a 4x4 matrix of pixels, the second number refers to the frequency with which the chrominance values (blue and red) are sampled horizontally, and the third number refers to the frequency with which the change in chrominance values are sampled vertically.



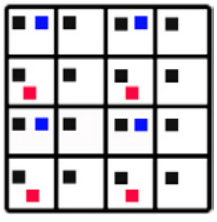
When every color element of every pixel is preserved, no color subsampling occurs resulting in a full bandwidth signal or 4:4:4. In this 4x4 matrix, every pixel contains information about luminance (black), Cb (blue) and Cr (red).

Graphics and video signals with 4:4:4 color deliver the most vivid and detailed imagery, but they require a lot more bandwidth to process and transmit. 4K signal processors (like our MediaWall V, Galileo, QuadView® UHD and SuperView® 4K processors) are designed to support and maintain this high level of color saturation. In addition, our MediaWall and Galileo processors and QuadView/SuperView multiviewers all process 4:4:4 signals without color subsampling. For optimal compression and transmission of signals, our DGy™ JPEG2000 codecs use 4:4:4 processing to deliver lossless imagery for the most demanding applications.



The diagram to the left depicts 4:2:2 color. Here, all of the luminance values are transmitted but only half of the color values. Although some color information must be recreated, 4:2:2 color is vivid, and imagery remains visibly sharp and clear.

To further reduce bandwidth, some processors subsample color at 4:1:1 (once every 4 pixels horizontally). However, this often results in bland color and image artifacts. For these reasons, this algorithm is only used in a limited range of applications.



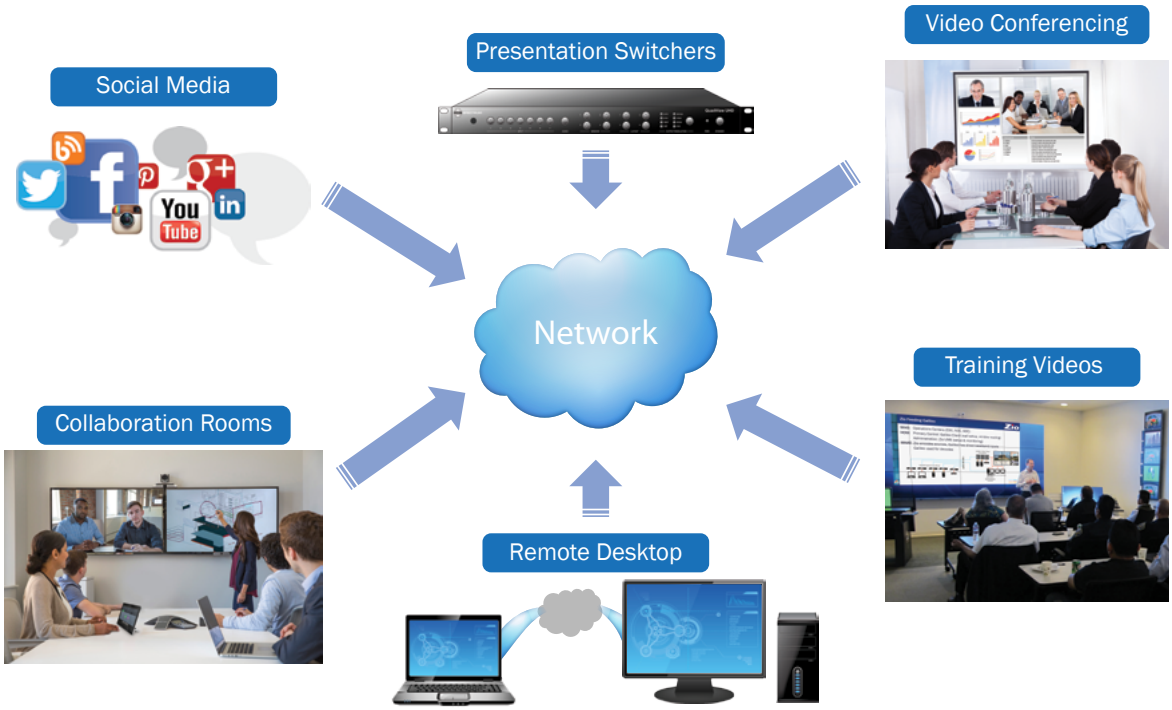
Another subsampling algorithm, which uses a similar bandwidth as 4:1:1 while delivering much better color resolution, is 4:2:0 (often used when processing and transmitting MPEG signals). This is the color sampling ratio used by our Zio® and DSx™ H.264 codecs. In such processing, color values are subsampled by half both horizontally and vertically. A typical 4:2:0 color subsample is shown at left. The distribution of color values allows a processor to recreate the original color more effectively than 4:1:1.

Color processing, conversion and transmission can be a challenge for video processors, but many are designed to deliver excellent performance on this front. If vivid color and sharp imagery is important to your application, be sure to look for a processor that is designed to process and transmit color resolutions effectively.

VIDEO – THE STANDARD FOR COMMUNICATION & COLLABORATION

Video usage has recently skyrocketed across all market applications. From security operation centers to social media centers, encoding and decoding video streams are now an integral part of the majority of AV projects. Long gone are the days of a completely centralized equipment room with miles of heavy, expensive baseband video cabling. Today's equipment rooms take up less space while still incorporating equipment located thousands of miles away.

Customers increasingly need content distribution across multiple rooms, buildings, and geographies. They are looking to integrators and consltants to provide a new solution that accommodates these needs.



Traditional baseband video distribution has several strengths:

- Lossless quality
- Low latency
- Fast switching

However, there are also some weaknesses associated with the hard-wired way of video distribution:

- Centralized switching and need for expensive extenders or optical connections for long cable runs
- Limited number of simultaneous devices supported
- Lack of platform flexibility - configuration and control
- Limited distance

While traditional solutions excel in close-proximity environments with a limited number of devices, new solutions are required for larger, distributed installations and IP streaming media support.

WHY NETWORKED AV?

Networked AV has been growing in popularity in the last few years. More and more AV projects are being handled by IT staff who feel quite at home with switches, routers and IP-based content. They have realized that there are some real benefits to using AV over IP.

COST SAVINGS

The use of commodity network routers/switches and Cat5/6 cables that are either already in place or are easy to find results in a huge cost savings.

Many Networked AV endpoints can take advantage of Power over Ethernet (PoE) which allows them to be powered from the network switch. This eliminates costly and bulky power supplies and cabling to help simplify installation.

DISTANCE

The need to integrate disparate sources that can be miles away is a probem for traditional, baseband connectivity. Networking infrastructure for AV over IP can be built across much greater disances, eliminiating any distance restrictions.

SCALABILITY

One of the key benefits of using Networked AV equipment is that there is no limit to the number of devices that can be connected together. Some systems may require a router for every certain number of endpoints which adds some cost to the overall system.

Other, more intelligent systems, such as Zio Networked AV products, auto-enumerate and distribute the managment across all devices negating the need for a centralized server.

As more encoders, decoders, multiviewers or wall processors are needed, they can simply be connected to the network. Some systems, such as Zio Networked AV, make the process of adding new devices even easier by auto-detecting them, providing plug and play operation.

If the ports on a network router are all filled, another router can easily be added to increase capacity.

FLEXIBILITY

Networks are present everywhere around the world which allows Networked AV products great flexibility. They can either share the existing data network or use their own, dedicated AV network. There are many tools available to separate the AV data from the standard office data to ensure both get the bandwidth they need to be most efficient.

INTEROPERABILITY

One of the benefits of having AV equipment on the same network as other devices is the ability to interoperate. A Smart TV, for example, can pull content directly from a media server IP camera, or Zio encoder and display it in a window along with today's weather in a hotel lobby.

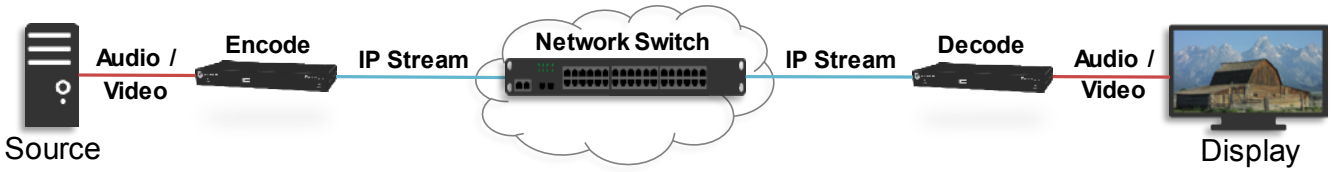
TRADITIONAL VS NETWORKED AV CONNECTIVITY

Audio-video connectivity is still typically accomplished with a high-capacity cable (i.e., HDMI, DVI, DisplayPort) from the source to the destination. While this still provides the highest signal quality, the source must be located within a short distance of the destination. This is often not feasible with today's distributed systems.

Networked AV connections offer the ability to move the source further from the destination and without compromising signal quality.

Traditional Digital/Analog Video

IP Video



STREAMING VIDEO & COMPRESSION

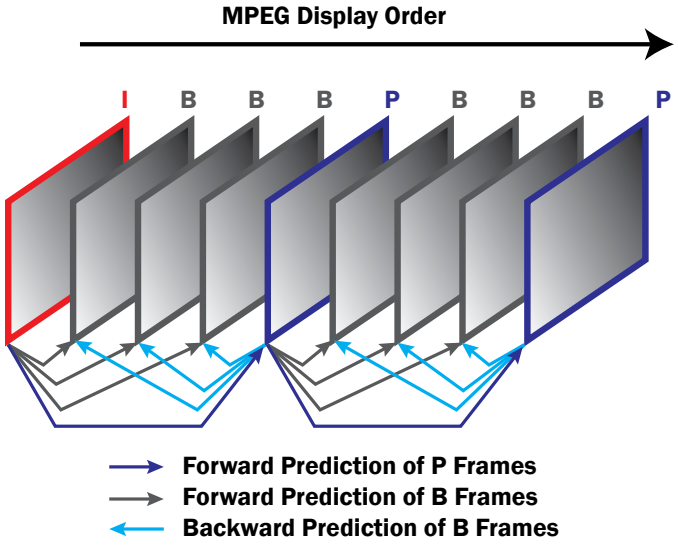
Conceptually, streaming refers to the delivery of a steady "stream" of media content that's been digitized for transmission over an IP network. Streamed content can consist of prerecorded data or real-time video, like camera feeds. What complicates streaming is that most data networks were designed for the transmission and delivery of data, rather than high-quality audio and video.

Bandwidth is a measure of the capacity of a network connection. While private internal networks may not suffer from bandwidth constraints, the public internet can be limited by bandwidth capacity, although that issue is improving. Fast Ethernet (up to 100 Mbps) has been replaced by Gigabit Ethernet (up to 1 Gbps) while 10 Gigabit and 40 Gigabit networks are not uncommon in many Network Operation Centers. However, because even relatively low resolution SVGA video (800x600) can require nearly 1 Gbps, data rates for the streaming delivery of HD video still exceed the bandwidth capacity of most network connections. For this reason, streaming of both high-resolution computer graphics and full-motion HD video over networks requires compression.

Video compression uses coding techniques to reduce redundancy within successive frames. There are two basic techniques used in the processing of video compression: spatial compression and temporal compression, although many compression algorithms employ both techniques. Spatial compression involves reordering or removing information to reduce file size. Spatial (or intraframe) compression is applied to each individual frame of the video, compressing pixel information as though it were a still image.

Temporal (or interframe) compression, as the name suggests, operates across time. It compares one still frame with an adjoining frame and, instead of saving all the information about each frame into the digital video file, only saves information about the differences between frames (frame differencing). This type of compression relies on the presence of periodic key frames, called "inter" or "I" frames. At each key frame, the entire still image is saved, and these complete pictures are used as the comparison frames for frame differencing. Temporal compression works best with video content that doesn't have a lot of motion (for example, talking heads).

The figure below illustrates the scheme used in temporal compression. In addition to the "I" frame explained above, "P" or predictive and "B" or bi-predictive frames are used to include data from the previous and next frames. The use of "B" frames is optional.



Temporal Compression Techniques

The Motion Pictures Experts Group (MPEG) Compression technique uses a Group of Pictures (GOP) to determine how many "I", "P", and "B" frames are used. A GOP size of one means that a each compressed frame will consist of a single I frame. This results in a lower latency but requires more bandwidth since less compression is used.

For still-image compression, there are two widely-used standards, both developed by the Joint Photographic Experts Group (JPEG). The original standard is known by the same name as the developing organization — JPEG — and it uses a spatial compression algorithm. A more recent standard, JPEG2000, uses a more efficient coding process. Both JPEG and JPEG2000 can also be used for coding motion video by encoding each frame separately.

UNICAST AND MULTICAST

There are two basic streaming architectures: unicast and multicast. Unicast streaming involves a one-to-one (point-to-point) connection between a server and a client; each client gets a unique data stream, and only those clients that request the stream will receive it. Unicast streaming works either for live streaming or on-demand streaming. The number of participants is limited by the bit rate of the video content being streamed, the speed of the server, and the bandwidth of the network conduit.

Multicast streaming involves a one-to-many relationship between the codec and the clients receiving the stream; all clients receive the same stream by subscribing to a designated multicast IP address. A virtually unlimited number of users can connect to a multicast stream. Because a single data stream is delivered simultaneously to multiple recipients, it reduces the server/network resources that would be needed to send out duplicate data streams. A network must be properly configured for multicast streaming, however. Depending on a network's infrastructure and type, multicast transmission may not be a feasible option.

H.264 PROFILES

In 2003, the MPEG completed the first version of a compression standard known as MPEG-4 Part 10, or H.264. Like other standards in the MPEG family, it uses temporal compression. Although H.264 is not the only compression method, it has become the most commonly used format for recording, compression, and streaming high definition video, and it is the method used to encode content on Blu-ray discs.

H.264 is a "family" of standards that includes a number of different sets of capabilities, or "profiles." All of these profiles rely heavily on temporal compression and motion prediction to reduce frame count. The three most commonly applied profiles are Baseline, Main, and High. Each of these profiles defines the specific encoding techniques and algorithms used to compress files.

Baseline Profile

This is the simplest profile used mostly for low-power, low-cost devices, including some videoconferencing and mobile applications. Baseline profiles can achieve a compression ratio of about 1000:1 — i.e. a stream of 1 Gbps can be compressed to about 1 Mbps. They use 4:2:0 chrominance sampling, which means that color information is sampled at half the vertical and half the horizontal frequency of the black and white information. Other important features of the Baseline Profile are the use of Universal Variable Length Coding (UVLC) and Context Adaptive Variable Length Coding (CAVLC) entropy coding techniques.

Main Profile

Main Profile includes all of the functionality of Baseline, but with improvements to frame prediction algorithms. It is used for SD digital TV broadcasts that use the MPEG-4 format, but not for HD broadcasts.

High Profile

H.264 High Profile is the most efficient and powerful profile in the H.264 family, and is the primary profile for broadcast and disc storage, particularly for HDTV and Blu-ray disc storage formats. It can achieve a compression ratio of about 2000:1. The High Profile also uses an adaptive transform that can select between 4x4 or 8x8-pixel blocks. For example, 4x4 blocks are used for portions of the picture that are dense with detail, while portions that have little detail are compressed using 8x8 blocks. The result is the preservation of video image quality while reducing network bandwidth requirements by up to 50 percent. By applying H.264 High Profile compression, a 1 Gbps stream can be compressed to about 512 Kbps.

In the H.264 standard, there are a number of different "levels" which specify constraints indicating a degree of required decoder performance for a profile. In practice, levels specify the maximum data rate and video resolution that a device can play back.

For example, a level of support within a profile will specify the maximum picture resolution, frame rate, and bit rate that a decoder may be capable of using. Lower levels mean lower resolutions, lower allowed maximum bitrates, and smaller memory requirements for storing reference frames. A decoder that conforms to a given level is required to be capable of decoding all bit streams that are encoded for that level and for all lower levels.

H.265 STANDARD

The High Efficiency Video Coding (HEVC) protocol, also known as H.265, was developed as a successor to H.264 by the Joint Collaborative Team on Video Coding (JCT-VC). The H.265 protocol reduces the bit rate required for streaming video when compared to H.264 while maintaining comparable video quality.

Due to the complexity of this new encoding/decoding protocol, more advanced processing is required. However, advantages such as lower latency can be realized with the H.265 procotol.

Some manufacturers, such as RGB Spectrum, take advantage of both H.264 and H.265 streaming protocols. Zio decoders, for example, can decode both H.264 and H.265 streams. This allows the customer to use whichever protocol is appropriate for the application.

LATENCY

When a digital video source is directly connected to a display using an interface such as DVI, video is easily passed without the need for compression. Transmission is virtually instantaneous, because no extra image signal processing is involved. But when compression techniques are used to make data streams more compatible with network bandwidth constraints, the processing takes a certain amount of time, known as latency. Latency is one of the key considerations for evaluating streaming products, processes, and applications.

PROTOCOLS

Many protocols exist for use in streaming media over networks. These protocols balance the trade-offs between reliable delivery, latency, and bandwidth requirements, and the selection of a set of protocols depends on the specific application.

One of the most common is Real-time Transport Protocol (RTP), which defines a standardized packet format for delivering audio and video over IP networks. RTP is often used in conjunction with Real-time Transport Control Protocol (RTCP), which monitors transmission statistics and quality of service (QoS) and aids synchronization of multiple streams. Both protocols work independently of the underlying Transport layer and Network layer protocols. A third protocol, Real Time Streaming Protocol (RTSP) is an Application layer protocol that is used for establishing and controlling real-time media sessions between end points, and that uses common transport commands like start, stop, and pause.

Generally, RTP runs on top of the User Datagram Protocol (UDP), a Transport-layer protocol that can deliver live-streaming with low latency, but without error-checking. RTP is generally used for multi-point, multicast streaming.

TRADEOFFS

While offering flexibility of distance and numerous other benefits, the ability to send an AV stream across a network comes with some tradeoffs.

There will always be a tradeoff in one of three areas:

- Bandwidth required
- Quality of the stream
- Latency between source and destination

LOWER LATENCY REQUIRED

If a lower latency between the original source, across the network, and display on a monitor is required, more bandwidth will be needed.

One way to achieve this is to use a smaller GOP size or use all I-frames (see “Streaming Video & Compression” on page 11). Time is needed to process a signal using a larger GOP size and its associated P and B frames. Hence if you need the signal to be sent with less time between the original encoding and the subsequent decoding, a smaller GOP size and/or using all I-frames will help achieve your goal.

If you need lower latency to simply switch between streams faster, RGB Spectrum’s Zio Networked AV decoders can decode additional streams in the background to enable instant switching.

HIGHER QUALITY REQUIRED

Achieving a higher-quality stream can be realized at the expense of bandwidth. By installing or upgrading network equipment to 10 Gigabit/port capacity, the frame rate, resolution and/or color subsampling of the stream can be increased. The result is a higher quality stream.

LOWER BANDWIDTH REQUIRED

Current H.264 implementations can maintain a high quality video signal while utilizing existing Gigabit Ethernet networking equipment. In these situations, lowering the color subsampling, frame rate and resolution will help reduce the bandwidth. This bandwidth reduction means more streams can be sent across the network.

BANDWIDTH REQUIREMENETS - SPATIAL COMPRESSION

Changing from one color subsampling ratio to another provides a signficant change to the bandwidth required for a video stream. The table below shows the bandwidth requirements for the three common color subsampling ratios at two standard video resolutions.

	1080p30/60	4Kp30/60
4:4:4	1.5/3Gbps	6/12Gbps
4:2:2	1/2Gbps	4/8Gbps
4:2:0	0.75/1.5Gbps	3/6Gbps

BANDWIDTH REQUIREMENTS - TEMPORAL COMPRESSION

In general, encoding a signal in H.264 format results in a compression ratio of between 20:1 and 30:1. The table below provides approximate bandwidth requirements when using H.264 compressed signals.

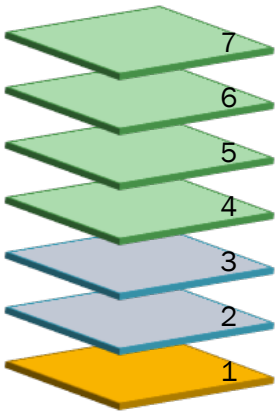
	1080p	4K
All I-frame	25Mbps	100Mbps
Normal GOP	6Mbps	24Mbps

NETWORKING FUNDAMENTALS

The increase in AV over IP has brought with it new terms and concepts that many AV professionals have not needed to know before. Likewise, may IT professionals are studying up on concepts that many AV experts already know. In this section, we cover some fundamentals of basic networking.

OSI MODEL[1]

The Open Systems Interconnection (OSI) model defines networking in terms of a vertical stack of seven layers. The upper layers of the OSI model represent software that implements network services like encryption and connection management. The lower layers of the OSI model implement hardware-oriented functions such as routing, addressing and flow control. All data that goes over a network connection passes through each of the seven layers.



OSI Layer Model

The OSI model was introduced in 1984. Designed to be an abstract model and teaching tool, the OSI model remains a useful tool for learning about today's network technologies such as Ethernet and protocols like IP. The OSI is maintained as a standard by the International Standards Organization.

The Flow of the OSI Model

Data communication in the OSI model starts with the top layer of the stack at the sending side, travels down the stack to the sender's lowest (bottom) layer, then traverses the physical network connection to the bottom layer on the receiving side, and up its OSI model stack.

For example, Internet Protocol (IP) corresponds to the Network layer of the OSI model, layer 3 (counting from the bottom). TCP and UDP correspond to OSI model layer 4, the Transport layer. Lower layers of the OSI model are represented by technologies such as Ethernet. Higher layers of the OSI model are represented by application protocols like TCP and UDP.

The Seven Layers of the OSI Model

The bottom three layers of the OSI Model are referred to as the Media layers, while the top four layers are the Host layers. The layers are numbered from 1 through 7 beginning at the bottom. The layers are:

Application layer (layer 7) - Network Process to Application. This end-user layer packages the data received from the Presentation layer in the format needed by the application or end-user process that receives it. Examples include browsers, SMTP, HTTP, and FTP. This layer also creates what is to be sent back to the Presentation layer.

The Presentation layer (layer 6) - Data Representation and Encryption, including format conversions. Think of this layer as the translator. Examples include ASCII, TIFF, JPEG, MIDI, and MPEG.

Session layer (layer 5) - Interhost Communication. This layer manages multiple types of communications and sends data to logical ports, including those using Network File System (NFS) and Structured Query Language (SQL).

Transport layer (layer 4) - End-to-End Connections and Reliability. As the name implies, this layer moves data across network connections, usually using TCP. It also handles error recovery and re-transmissions.

Network layer (layer 3) - Path Determination, IP, and Routing. Layer 3 formats data as packets. Directs the data to the correct physical path.

Data Link layer (layer 2) - This is the most complex layer in the OSI model, and it is sometimes divided into two parts: one for media access control and one for logical link control.

The Physical layer (layer 1) - Media, Signal and Binary Transmission. Examples include hubs, repeaters, and Ethernet cables. Data is transmitted by an electric voltage, radio frequencies, infrared or ordinary light.

LAYER 2, LAYER 2+ AND LAYER 3 SWITCHES

Layer 2 switches are typically used for implementations across a Local Area Network (LAN) while Layer 3 switches are used for a Wide Area Network (WAN). Layer 2 switches are now available that incorporate some of the Layer 3 functionality at a reduced cost. These are called Layer 2+ (Plus) switches.

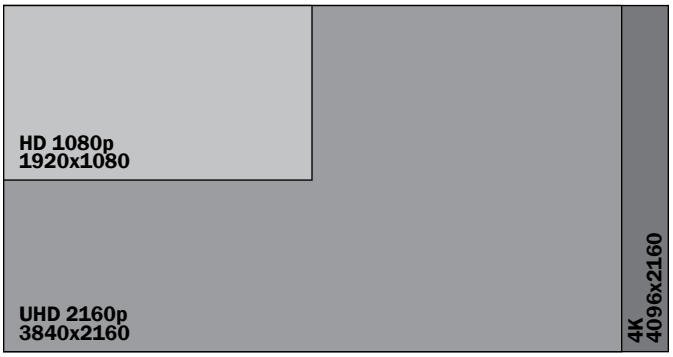
The most notable feature contained in Layer 2+ switches is Internet Group Manageent Protocol (IGMP). This communications protocol is used to manage the devices in multicast implementations.

1 Bradley Mitchell, "Understanding the Open Systems Interconnection Model", https://www.lifewire.com, (June 9, 2017)

In this age of ever-increasing video resolutions, 4K (also known as UHD or Ultra HD) technology has moved into the spotlight. 4K/UHD resolution offers considerable value in control room and audiovisual environments that require the highest level of visual clarity. Delivering 3840x2160 (8.3 million) pixels per display, it significantly enhances an operator's ability to monitor and analyze finely detailed imagery.

The initial sections of this primer present an overview of 4K resolution and explore some technical considerations related to the deployment of 4K video processing and display technologies. The latter sections discuss the many ways in which RGB Spectrum video processors deal with 4K and UHD signals.

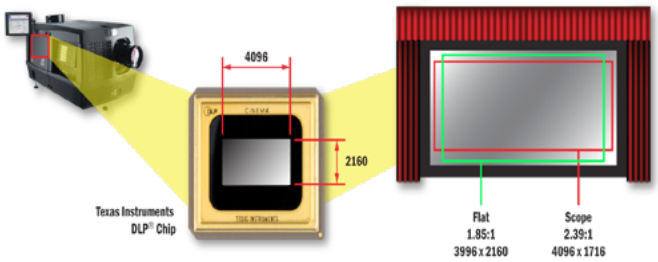
High definition (HD) resolutions (1920x1080) and DVI single-link resolutions (1920x1200) have become commonplace — at home, on desktops and on video walls. However, the term "4K" requires some clarification, because "4K" and "UHD" have different meanings and correspond to different resolutions depending upon the vertical market. For the display market, UHD means 3840x2160 (exactly four times HD), and 4K is often used interchangeably to refer to that same resolution. For the digital cinema market, however, 4K means 4096x2160, or 256 pixels wider than UHD.



Resolution comparison — HD, UHD, and 4K

The reason for this wider 4K resolution, is that 4K digital cinema projectors must accommodate films that are produced in both "Flat" (1.85:1) and "Scope" (2:39:1) aspect ratios. The pixel resolution of Flat is 3996x2160, while the resolution of Scope is 4096x1716.

The choice of aspect ratio is determined by a film's director and cinematographer, but the DLP® (Digital Light Processing) chip inside most projector engines is designed to accommodate both of these resolutions — the wider "scope" and the taller "flat."



The DLP Chip accommodates two digital cinema film aspect ratios

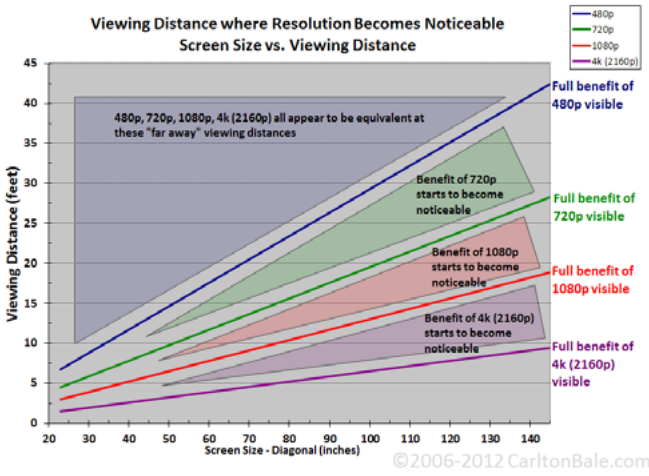
DISPLAY SIZE, RESOLUTION & VIEWING DISTANCE

4K technology is becoming more mainstream, and 4K monitors more affordable. As a result, we are increasingly seeing 4K UHD products deployed in a wide range of market areas. However, the limitations imposed by human vision raise some interesting questions about 4K deployment. What applications can benefit most from this higher pixel density and, by extension, in which situations is the incorporation of 4K UHD processing technology most effective?

Human vision is confined to a narrow spectrum of wavelengths and resolutions. The eye is capable of resolving various densities and pixel sizes, but in a control room (or at home) this ability is greatly affected by the distance between the viewer and the display.

Display devices are available in a wide range of sizes and resolutions. The smaller the screen's diagonal size, the more densely packed its pixels will be, and the closer one would need to sit in order to discern a visible difference between lower and higher resolutions.

Display size and viewing distance are two critical factors that help determine the situations in which 4K resolution would add value to an application — regardless of whether the application resides on a video wall or on the desktop. The following chart, created by Carlton Bale (www.carltonbale.com) compares screen size and pixel density, and clearly illustrates the ideal viewing distances for each combination.



Viewing Distance / Resolution Comparison Chart

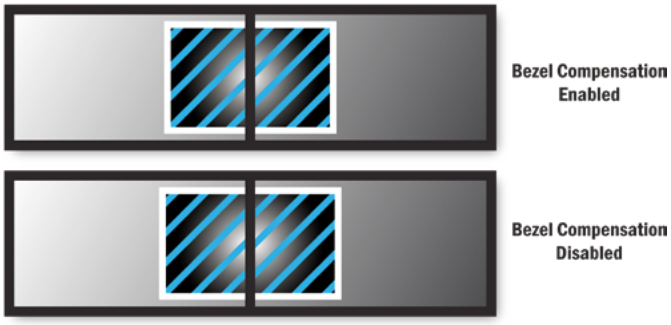
As the chart above illustrates, if one is viewing 4K signals on a small screen (e.g., 50 inches diagonal or less), the ideal viewing distance is approximately five feet. If one is farther away from the display, 4K imagery will effectively appear identical to that on an HD display. With 4K imagery on a larger screen (e.g., 80 to 105 inches diagonal), the ideal viewing distance increases to 12-15 feet. In contrast, the ideal viewing distance for a typical 50 inch 1080p HD display is approximately 12-15 feet, and 15-20 feet for a 105 inch 1080p display.

BEZELS AND VIDEO WALLS

When constructing a multi-monitor video wall, another key customer consideration is the total amount of continuous display space between monitor bezels. These bezels (also known as mullions) provide a rigid support structure for the LCD panels in each display. However, on a video wall, bezels also break up the continuous appearance of images that may be scaled across multiple monitors.

As standard, all RGB Spectrum wall processors provide the ability to compensate for the width of the display bezels. With compensation enabled, an image that is scaled across multiple monitors will appear perfectly normal, as if it is located "behind" the bezels. This type of compensation would be ideal for a digital signage application, or a large wall display designed to be "eye candy." On the other hand, for a critical security application, the customer may elect to disable compensation, so that every pixel is viewable and no pixels are hidden behind the bezels.

In the following diagram, two monitors with very large bezels are used for illustration purposes only. In the top array, bezel compensation is enabled, and the diagonal stripes appear perfectly continuous, as if they are behind the bezels. In the bottom array, bezel compensation is turned off, no pixels are hidden, and thus the diagonal strips do not appear continuous.



Monitor Array with and without bezel compensation

Note that with a 4K UHD video wall, larger format display devices can also be used, thus reducing the total number of bezels on the wall. If continuous imagery is important to one's application, then 4K UHD resolution monitors offer this added benefit.

4K UHD VIDEO WALL PLACEMENT

If you need to construct a video wall with the fewest bezels possible and the wall will likely be viewed from a maximum distance of 10-15 feet, then large-format 4K UHD displays (84"-104") may be the best fit for your installation. In contrast, if a customer wants to use smaller monitors and the planned viewing distance is greater than 15 feet from the wall, then 1080p displays may be a more cost-effective choice.

Most control room applications typically involve workstations located a specific distance from a central video wall, so the viewing distance/display size guidelines can help you choose what kind of a wall is most appropriate for your system. Keep in mind that RGB Spectrum's MediaWall V and Galileo processors can configure a range of resolutions for display on either 4K UHD or 1080p HD video walls.

Notable Exceptions

Some video wall applications are exceptions to the guidelines listed above, because they often require close-up inspection of ultra-high resolution imagery. These applications include:

- Medical imaging
- Simulation modeling for oil and gas exploration
- Manufacturing inspection systems
- Aerial reconnaissance
- Megapixel surveillance

In these cases, where short viewing distances are mandated, the highest resolution displays should be employed, and 4K UHD processing equipment such as the MediaWall V or Galileo display processor is the logical choice.

A WORD ABOUT RESOLUTION

If you elect to build a video wall out of 2K HD displays, does a 4K UHD processor still have value? Absolutely. Typically, a variety of input signals feed into a video wall processor, and these images may be spread out across multiple monitors. The pixel density of the input determines how large the image can be expanded, without negatively impacting the clarity of the original image.

For example, a 24-monitor video wall comprised of 2K HD (1920x1080) displays offers a total of 50 million pixels — enough real estate to display six 4K input signals at full resolution. The lower pixel density of the monitors means that those 4K UHD signals can be expanded across more monitors, while still maintaining native image quality. This use case is particularly relevant for "large wall" installations that require finely detailed imagery to be displayed (e.g., multi-megapixel surveillance, satellite telemetry, industrial control applications, and geospatial modeling).

By using 4K UHD inputs, customers have the pixel density required to configure large windows on a large wall, regardless of whether that wall is built with 2K HD or 4K UHD displays.

A NEW PARADIGM — THE DESKTOP WALL

Video wall imagery is typically composed of windows containing graphics or video content provided by source systems such as computers or set top boxes. Today, most source systems output 1080p video, which would entirely cover one 1080p monitor — if the video is displayed un-scaled.

A single 4K workstation monitor packs 8.3 million pixels into a desktop size display, in diagonal sizes ranging from 27" to 32". How could this type of display technology be used to create a "desktop" video wall?

If a 4K UHD desktop monitor is used in conjunction with an RGB Spectrum MediaWall V processor or QuadView UHD multiviewer, one could display four full-resolution (un-scaled) 1080p input windows on screen — one in each quadrant of the monitor. If a workstation is configured with three adjacent 4K UHD displays, for example, an operator could monitor 12 full resolution video feeds with superb clarity. This is a remarkable amount of data, displayed without any loss of resolution — and all possible with the MediaWall V processor.

A 4K desktop wall would be ideal for customers that need to track real-time video/graphic information from a multitude of sources in high resolution, particularly if a VMS (Video Management Software) program is employed. These systems multiplex large numbers of cameras onto a single screen, and are utilized in applications such as traffic management centers, casinos, and municipal emergency operations centers. The pixel density provided by a 4K desktop wall results in unsurpassed image clarity, no matter how closely an operator views the monitors.

In this manner, the MediaWall V processor enables the "Desktop" wall as a viable concept. For added functionality, the MediaWall V processor is compatible with RGB Spectrum's Enterprise MCMS, a powerful control room system that allows operators to share keyboard and mouse control over multiple system resources. The result is a customizable workstation-based control room solution with incredibly powerful UHD video display capabilities.

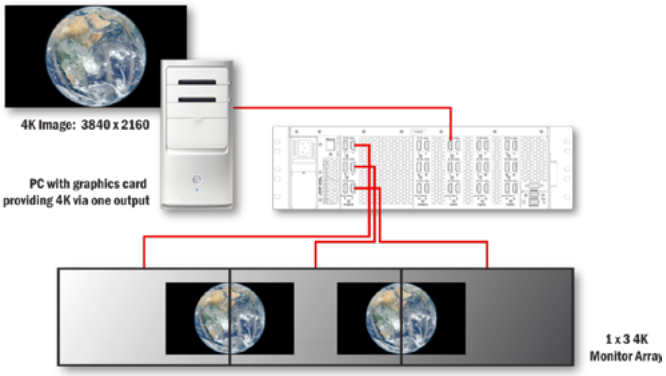
A PIONEER IN 4K PROCESSING

RGB Spectrum has been at the forefront of 4K product development since the launch of its SuperView 4K Multiviewer in early 2013. With the introduction of the next-generation MediaWall V and Galileo Display Processors and the QuadView UHD multiviewer and Zio networked AV products, the process of connecting, manipulating and processing 4K signals is greatly simplified.

These products are designed to input and output 4K signals via the HDMI 1.4 format. As compared to HDMI 1.3, which (in general) processes 1080p signals, HDMI 1.4 increases the resolution to 4096x2160 at 24Hz (for digital cinema) and 3840x2160 at 24 or 30Hz. In addition to HDMI, the Galileo and MediaWall V display processors also output signals in the DisplayPort format, allowing it to provide output signals up to 4096x2160 at 60Hz.

To the layman, this means a single-wire 4K connection to and from the display processor or multiviewer — obviating the need to split the 4K signal into four HD quadrants.

As a result, the connection from a 4K source to the display processor is via a single HDMI cable — provided that the PC with the 4K source has a graphics card capable of delivering 4K via one output port. Similarly, the connection from the display processor or multiviewer to one (or more) 4K monitors is also via single cable.



MediaWall V 4K input and output connection

Beyond the display of 4K imagery, a big advantage of incorporating 4K-enabled systems into control room or audiovisual environments is having 8 megapixels of resolution. This allows, for example, multiple HD images to be viewed in their original, native resolution. RGB Spectrum's MediaWall V and Galileo display processors, QuadView UHD multiviewer, and Zio Networked AV products support single-wire 4K inputs and outputs, as well as lower-resolution input/output signals.

SYSTEM DESIGN PRINCIPLES

PURPOSE-BUILT PRODUCT ARCHITECTURES

Every successful innovation begins with basic decisions about product architecture. During the design process, developers must balance performance requirements with customer needs in order to determine the best approach. These strategic decisions determine how the internal architecture of a particular product should be structured. A skillful designer often must reconcile competing priorities but still ensure that the end result compares favorably with rival products. At RGB Spectrum, we develop "purpose-built" real-time architectures for each of our products that maximize functionality and performance. This approach has allowed product after product to achieve the distinction of being "best in class."

When designing video and graphics processing products, many companies begin with a standard PC-based architecture. On the surface, this seems like a logical choice; processing cores are pre-defined, and a company simply needs to add the required inputs/outputs and design a software system to move information between these elements. When you introduce multiple streams of graphics into traditional non-real-time systems, however, you very quickly reach system bandwidth limitations, and it becomes increasingly difficult to process and route content reliably.

Processing live video inputs requires even more system resources than graphics rendering. Graphic images consist of a certain number of individual pixels arranged in a two-dimensional array. Video images, on the other hand, consist of a sequence of still images, known as frames, which are displayed in a continuous stream. The higher the frame rate, the smoother the motion of the video will be.

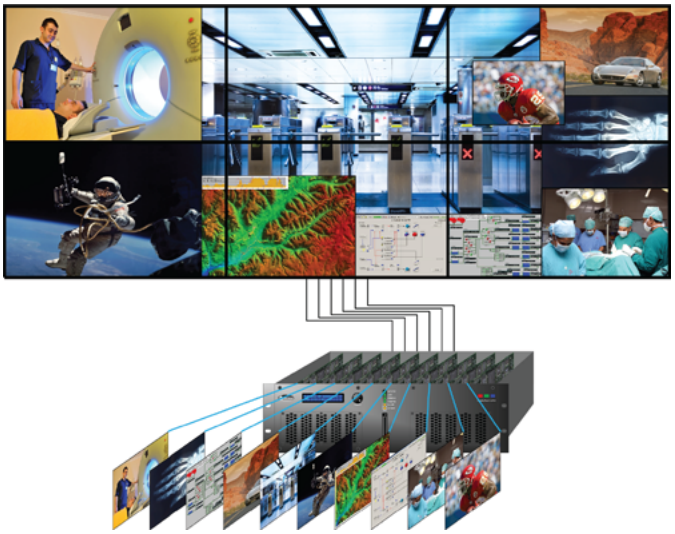
Video signals are generally transmitted at 30 or 60 frames per second. If a non-real-time system is busy with another task (i.e. responding to high priority network or disk requests), it may not able to process every frame and pixel of the video input stream, and may have to skip frames to compensate. For example, a video wall system that incorporates non-real-time technologies may work fine with a small number of live video inputs, but may drop frames when additional inputs are introduced.

RGB Spectrum offers a different approach to system and product design, with a focus on developing products that combine excellent image quality with 24/7 reliability. Early on in its over 30 year history, the company realized that in order to create such products, they would have to incorporate a radically different approach to product design, centered around "purpose-built" processing engines that allow the end function of the product to determine the most suitable internal architecture.

RGB Spectrum's "no-compromise" design approach supports the highest quality processing of video signals. Real-time hardware ensures that every pixel and every frame that enters the system is processed, and that the full frame rate is displayed on the output. The amount of bandwidth needed to accomplish this effectively is incorporated into each product, and this allows RGB Spectrum's products to reliably process and output pristine video and graphics signals in real time, with no dropped frames.

A major benefit provided by RGB Spectrum's purpose-built architectures is the short interval of time between when a unit is powered on and the appearance of a stable display. Once configured, our systems are designed to recover rapidly from unexpected power interruptions. For example, even if a system is switched off or disconnected from the power supply, an RGB Spectrum video wall processor will subsequently restore operations almost immediately, without requiring lengthy boot time. Finally, the absence of a disk drive helps minimize boot time and results in a system that is intrinsically immune to viruses and malware.

The purpose-built, real-time architectures that are fundamental to RGB Spectrum's design approach deliver fully-customized products characterized by superior image quality, enhanced functionality, and our renowned 24/7 reliability.



RGB Spectrum's purpose-built architectures and real-time parallel processing deliver consistently reliable results

SOLUTIONS-BASED SYSTEMS DESIGN

"BRINGING IT TOGETHER"

RGB Spectrum's system solutions combine hardware components and control room management tools with an intuitive user interface that simplifies operation. With a range of components and options, our versatile solutions can be customized for any application.

Our solutions are differentiated by the fact that they use video, rather than custom software, to enable integration of, and communication between, disparate systems. This approach allows video from different systems to be captured, switched, processed, composited, displayed, and controlled, all without the need for traditional software integration.

Using video as an integration enabler reduces the time required to implement complex integration projects and it eliminates issues related to system inter-dependencies. It allows information from even legacy systems that could not be integrated otherwise, to be displayed and controlled like any other resource. And it provides operators with a unified desktop control interface that is intuitive and easy to use.

Our fully customizable solutions integrate a myriad of features including IP connectivity, remote system monitoring and control, video encoding, signal switching, display processing (video wall and multiviewer), and control room management. For enhanced flexibility, individual system components are designed for interoperability both with each other, and with a range of third-party equipment.

Our application-based system solutions fall broadly into the following three categories:

CONTROL & DECISION SUPPORT SOLUTIONS

RGB Spectrum's customizable control and decision support solutions with IP capabilities integrate multiple disparate systems under the control of a unified interface.

Designed for 24/7 reliability and the highest level of security, our integrated solutions are ideal for use in a range of mission-critical applications such as command centers, control rooms, industrial automation, remote monitoring, police/public safety emergency operations centers (EOCs), fusion centers, as well as in enterprise and campus security operations centers (SOCs).

These solutions enhance situational awareness and response, allowing operators to make better decisions, faster.

VISUALIZATION & COLLABORATION SOLUTIONS

RGB Spectrum's system solutions for visualization and collaborative work environments offer real-time video processing, integrated KVM, and arbitrated control management to enhance situational awareness and support multi-operator and multi-site workflows.

Fully customizable for a range of mission-critical applications, these IP enabled video processing and control management solutions provide powerful visualization which enhances collaborative response.

SWITCHING & TRANSMISSION SOLUTIONS

RGB Spectrum offers a range of scalable switching and transmission solutions that route signals through individual rooms and buildings. For enterprise-level applications, these solutions can also provide multiple sites with IP-based connectivity and control, remote KVM functionality and secure signal transmission.

Remote capabilities and real-time signal processing in collaboration, control, conference and board rooms support multi-site workflows and critical decision-making.

DESIGN SERVICES

To better meet the needs of our valued partners, RGB Spectrum is pleased to offer a complimentary Design Services program, which provides custom-designed system solutions. Our technical services team understands the intricacies of our products, and is trained to design systems which best utilize their capabilities.

In response to a request, the team will create design drawings embedded with full, detailed information/specifications related to each system component. Completed drawings are accompanied by an automatically generated Bill of Materials (BOM), a full listing of the included components, to reduce the possibility of human error.

Guided by strong design principles and a process that combines extreme consistency with the creativity to design innovative system solutions, the team develops the most efficient and cost effective system for a customer's requirements. Design Services system diagrams can easily be incorporated into a larger overall system, which complements the work done by our partners' design teams.

To access this resource, you must be an authorized RGB Spectrum partner (rep, integrator, specifier or consultant) with a website partner portal account. If you do not currently have access, please visit www.rgb.com/partners to request an account. If you are already registered and would like design help with a specific project, please log into the portal and submit an Engineering Design Services Request.

RGB Spectrum provides a range of system control options which can be combined with its hardware offerings into powerful and versatile solutions for a range of applications. Tell us what you need, and we'll work with you to create a purpose-built, custom-designed solution that is right for your project's requirements.

SMARTER SYSTEMS INTEGRATION

Integrating disparate computer systems is a constant challenge for those seeking to effectively manage control room resources. Traditional approaches often fall short because they are too complex, time-consuming and costly. RGB Spectrum offers a better solution: integrating with video.

Wikipedia defines systems integration as "the process of linking together different computing systems and software applications physically or functionally, to act as a coordinated whole." In other words, the primary purpose of systems integration is to allow disparate systems to communicate with each other and be controlled in a unified manner.

Technological innovations have led to a significant increase in the number, type, and complexity of systems requiring integrated control in any monitoring environment. If we consider building automation, for example, facilities have systems that monitor and control various components including HVAC, access points, elevators, water systems, lighting, fire alarms, announcement and intercom systems, burglar alarms, phone networks, location tracking, and video surveillance equipment.

These discrete systems are typically monitored by several different operators. However, to ensure optimal functioning of the entire facility, systems need to be able to communicate with each other, and be easily accessible, especially in the event of an emergency. Such unified control can only be accomplished through systems integration.

TRADITIONAL INTEGRATION STRATEGIES

In the traditional approach, systems communicate with each other using custom software. Developing this software is a time consuming, difficult, and expensive undertaking. Every time an integrated application is upgraded, the communication links between every system must be updated as well, requiring additional time and money. As a result, traditional integration with custom software creates dependencies which can severely limit the ability to upgrade/update individual systems.

In addition, today's complex systems must provide flexible access to data. Who requires access to what information, when and where, can change dramatically over the course of a day. At the same time, system information must also be securely protected from unauthorized access or tampering. You need an integration solution that can address these multiple requirements.

INTEGRATING WITH VIDEO: A BETTER SOLUTION

Every system must display some kind of visual signal to enable operators to respond to system cues. This is usually done through a graphical user interface (GUI) or human machine interface (HMI), which allows operators to access system information. Integrating using video signals is a more logical choice than custom software when your objective is to consolidate control because all systems communicate using some kind of visual output.

Building upon this concept, RGB Spectrum has created a comprehensive set of tools that integrate systems using video. RGB Spectrum technology allows video from different systems to be captured, switched, processed, composited,

displayed, and controlled, all without the need for traditional software integration.

Key features of this approach include:

- **Video Based Integration** – Almost every system has some type of standard video output. Plug this output into an RGB Spectrum processor and it can become an integrated and controllable part of the system.
- **Unified Control Interface** – Video signals from different systems are consolidated to appear to end-user operators as part of a unified control platform.
- **KlickSimple™ Technology** – Keyboard and mouse (KVM) control can be shared over a private Ethernet network between the source systems and end user operators. This private network transports only keyboard and mouse commands to protect system resources.
- **Integrated Visual Management** – Operators can share video with each other and display on a video wall with a simple mouse click using our intuitive and easy to use VIEW™ Controller to manage control of visual resources.
- **IP Transmission** – Video and KVM control signals can be securely encoded for transmission over IP networks for both remote inbound system viewing and/or control and remote operator collaboration.
- **Scripting and Control APIs** – These allow complete access to the video processing environment for automation purposes without creating dependencies between source systems.

RGB Spectrum's control room integration platform provides a number of important benefits. The platform consolidates system monitoring and control, while the individual systems remain in separate networks. This reduces the risks associated with having a single point of convergence/failure when all systems are connected to each other. Within this system architecture, source systems can also be updated independently of each other, without any software dependencies.

For multiple-user environments, sophisticated control arbitration features in our Enterprise MultiPoint® Control Room Management System (MCMS) product allow operators to share control over system resources and enables administrators to delineate/restrict access levels. Video from several source systems can be composited into a single video signal which can then be securely encoded and distributed to remote users, reducing bandwidth requirements. Finally, real-time video processing allows all operators to see the same video at exactly the same moment, with no encoding delay variation.

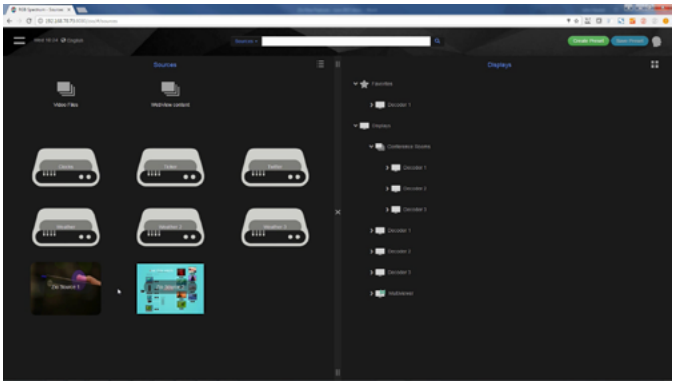
Using video as an integration enabler reduces the time required to implement complex integration projects and it eliminates issues related to system inter-dependencies. It allows systems that otherwise could not be integrated to be displayed and controlled like any other resource. And it provides operators with a unified desktop control interface that is intuitive and easy to use.

CONTROLLING RGB SPECTRUM EQUIPMENT

A highlight of RGB Spectrum products is that they can be easily controlled through a variety of software and hardware solutions. Most products include an embedded Web Control Panel™ (WCP) that provides an easy-to-use graphical user interface. Several products also offer front-panel controls. Additional control options include product-specific controller software. In addition, RGB Spectrum products are compatible with third-party control systems.

ZIO CONTROL INTERFACE

RGB Spectrum's Zio Networked AV product line provides a simple, powerful interface that is available via any standard web browser. The Zio user interface displays live thumbnails of each stream so users can preview content directly in the broswer-based interface and use the drag-and-drop capability to send content to one destination or many. Search tools make finding the right content quick and easy. Any number of users can control distribution of content and manage endpoints - via PC or tablet.



Zio Networed AV Simplified Interface

WEB CONTROL PANEL (WCP)

RGB Spectrum's Web Control Panel (WCP) is a web-based graphical user interface that offers an intuitive and hassle-free way to set up control parameters and operate many RGB Spectrum products. The WCP provides interactive control of window size, position and labeling, and quick preset recall. Like all of RGB Spectrum's products, WCPs are easy to operate. Our intuitive design dramatically reduces the cost associated with installation, training and support, which enhances the customer's return on investment. Robust equipment that is easy to operate and less vulnerable to human operational errors helps minimize downtime and improve system efficiency. Each RGB Spectrum product has a specific WCP that is custom designed to complement its functionality.

COMMAND LINE INTERFACE

All RGB Spectrum products can be controlled by issuing commands through a serial RS-232 port or through an Ethernet port using the terminal window in the WCP or

a Telnet session. Operators can use the command line interface to obtain system information, set particular parameters, and/or execute a range of functions.

VIEW CONTROLLER

VIEW Controller is a software control solution that offers an easy, intuitive and highly graphical control option for complex systems.

VIEW Controller for MediaWall V

VIEW Controller is available for MediaWall V display processors. These controllers are simple to operate and offer a range of user-friendly features. For example, the enhanced functionality of the graphical user interface allows users to “drag and drop” sources to route them. VIEW Controllers also generate thumbnails of each source connected to the processor to further simplify operation. The real-time nature of the controllers means that changes take effect immediately without having to physically apply changes or refresh screens.

THIRD-PARTY CONTROL

Because customers often need to integrate RGB Spectrum’s products into an existing control infrastructure, our products are compatible with a wide range of control systems manufactured by third-party companies such as AMX, Crestron, Extron and RTI. For AMX and Crestron, RGB Spectrum provides downloadable code blocks. These code blocks function essentially as “middleware,” which enables system integrators to seamlessly connect RGB Spectrum’s processors to a customer’s current control system, and achieve full functionality without the need for complex programming.

RGB Spectrum also offers specialized control for hand held wireless devices such as tablets and smartphones. Users can activate presets on switchers, multiviewers and display processors. Security is enabled through the product’s administration menus.

Examples of third-party controllers

CONTROLLING EXTERNAL SYSTEMS

RGB Spectrum offers robust solutions for controlling external systems. These control options are designed to work with video walls to enhance collaboration and simplify multi-user control of complex systems. MultiPoint® Enterprise and MultiPoint Express solutions provide multiple operators with the ability to integrate disparate systems under the control of a single unified interface.

MULTIPOINT CONTROL ROOM MANAGEMENT SYSTEM

RGB Spectrum's MultiPoint Control Room Management System (MCMS) is a collaborative system for accessing, displaying, and controlling shared computer and visual resources. Fully-featured, modular and customizable, MCMS is a complete software and hardware solution that enables multiple operators, whether local or remote, to manage a facility's enterprise resources effectively.

MultiPoint Enterprise and MultiPoint Express can be used for control management in a variety of applications: command centers, security operations centers, emergency operations centers, process control, network operations centers, and SCADA systems monitoring.

Video Quality

The system processes video signals in their native resolution, frame rate and color information without processing delays. Uncompressed signals up to 3840x2160 can be displayed anywhere on the system.

Collaboration

Collaboration is based on the explicit grant and release of control over source computers. A system of user-assignable permissions and priorities allows complete flexibility to tailor a system to a specific set of requirements. Operators can request, transfer or relinquish control within seconds. Senior operators can take immediate control.

Architecture

The hybrid architecture of MCMS combines the image quality of baseband video with the flexibility and intelligence of IP.

Unlike systems that use IP for passing all the video information, MultiPoint Enterprise uses a high-speed AV network built on RGB Spectrum's high-capacity Linx™ switching platforms. MultiPoint Express uses the switching capabilities built into the MediaWall V display processor.

Switchers route local computer and video sources through a hardware-based switch fabric to provide full resolution and frame rate performance superior to video-over-IP systems.

Only commands are routed over IP, which places almost no burden on the network. This hybrid architecture is ideal for mission-critical, real-time display processing. Optional remote desktop options can provide secure access to computers located even thousands of miles away.

MultiPoint Enterprise is a modular, customizable system which users can build up with increasing capabilities:

- Multiple operator stations each with video and computer monitoring and control
- Compatible with RGB Spectrum's MediaWall Processors for video wall functionality
- Adding H.264 codecs enables remote monitoring, transmission and recording of video streams
- Systems are available with a variety of switcher and video wall configurations to enhance flexibility

User Interface

With an intuitive control interface, MCMS makes it easy for operators of all skill levels to use KVM control to display and access applications running on different computers.

The user interface offers a simple "drag-and-drop" method

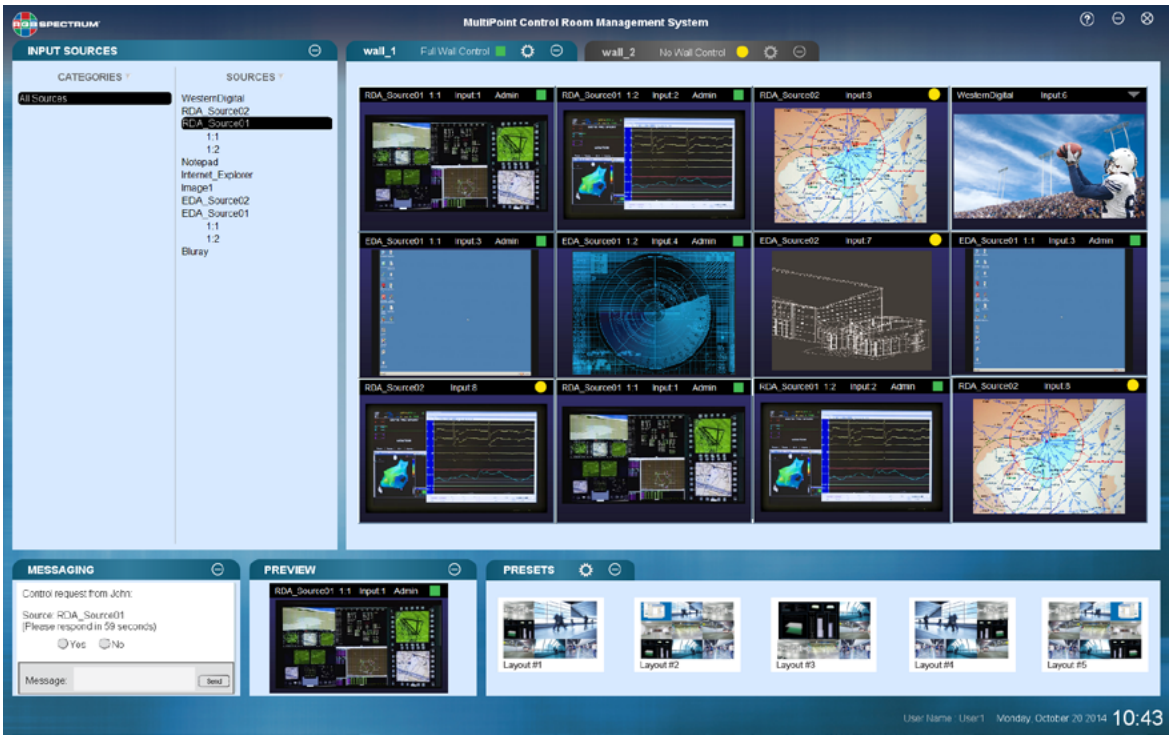
of placing sources on an operator's personal displays as well as on a video wall. Designed for a collaborative work environment, this intuitive interface is the cornerstone of the MCMS integrated hardware / software platform.

KlickSimple Navigation

KlickSimple™ navigation allows seamless mouse and keyboard control across displays. An operator can use the mouse to select computers and provide control by simply moving the cursor into the associated screen. With no buttons to push, the hand never has to leave the mouse. KlickSimple technology makes it easier for multiple operators to work collaboratively.

Its intuitive user interface, superb image quality, high level of security, and sophisticated arbitration combine to make Enterprise MCMS the industry standard for control room management.

One keyboard and mouse controls three sources



MultiPoint Enterprise User Interface

PRODUCTS DIRECTORY

The following sections present an overview of RGB Spectrum's main product lines. For back panel drawings of individual products, please refer to the "Product Matrix" beginning on page 40. For more detailed information and exact dimensions, please refer to technical specifications and drawings on the product pages of our website at www.rgb.com.

NETWORKED AV PRODUCTS

RGB Spectrum's Zio® AV over IP technology offers video and audio distribution over an IP network, replacing traditional dedicated switchers. Zio endpoints attach to a conventional1Gig Ethernet switch, with encoders accepting computer and video signals at resolutions up to 4K, and decoders for feeding displays. The Zio system offers seamless switching over the IP network infrastructure. Both dedicated and shared networks are supported.

For moving large amounts of data, an IP infrastructure excels. However, distributed video sources and destinations create unique challenges for time-sensitive and time-ordered video streams. Zio's transport technologies and unique peer-to-peer architecture address these problems, with exceptional user control and performance management. An AV over IP system with a distributed management platform avoids costly server architectures and "single point of failure" vulnerability.

An optional WebView feature enables Zio decoders and multiviewers to decode and display web content and UDP multicast streams in addition to RTSP streams.

A room, a building, a campus, a city, or the world – LANs, WANs, even satellite links – Zio is up to the challenge.

ZIO ENCODERS AND DECODERS

Product Link

The Zio product line includes encoder and decoder models that support 2K or 4K video over IP. Zio endpoints encode and decode video, audio, and control signals using industry standard compression.

The S2002 model IP video encoder accepts signals up to 2K resolution via locking HDMI connector with loop through capability. The S2004 model accepts signals up to 4K resolution.

The Zio D2000 Series are flexible decoders designed to work with the S2000 Series encoders and H.264/H.265 compliant devices. The D2002 model IP video decoder displays streams at up to 2K resolution. The D2004 model decodes and displays streams at up to 4K resolution. Power over Ethernet (PoE) is provided on both models to simplify installation.

The S2000 Series Encoder can encode content that has been encrypted using HDCP 1.4. The streamed content is encrypted using HDCP 2.2 for transport over the network. The D2000 Series Decoder decodes the encrypted, HDCP 2.2 stream and converts it to an HDCP 1.4 signal for output to the display.

To protect sensitive data and prevent tampering during transmission over public networks, the S2000 Series Encoder can encode unencrypted content using a proprietary encryption method based on the AES-256 standard.

ZIO MULTIVIEWERS

Product Link

The compact Zio D2000 Series multiviewers allow multiple streams to be decoded and viewed on a single display. The D2022 model IP multiviewer allows up to four 1080p streams, or equivalents, to be placed on a screen any size, anywhere. Power over Ethernet (PoE) is provided to simplify installation.

The Zio D3000 Series multiviewers build on the functionality of the D2000 Series, increasing the number of simultaneous streams displayed. The D3124 model allows up to sixteen 1K, eight 2K or two 4K streams, or other equivalents.

ZIO WALL PROCESSORS

Product Link

Our advanced Zio Networked AV platform includes comprehensive video wall capabilities making it the latest addition to RGB Spectrum's extensive choice of display wall processors. Zio encoders allow signals up to 4K UHD to be encoded, sent across a standard IP network, and decoded for display in a window on the video wall. From a simple 2x2 wall array in a lobby to multiple walls across a corporate campus, the Zio wall processor family provides the flexibility required for any video wall application.

The Zio D3000 Series IP video wall processors are flexible decoders designed to work with the S2000 Series encoders and H.264/H.265 compliant sources. The D3062 model decodes up to four, 2K resolution IP streams. The D3164/3174/3184/3194 models decode and display up to ten, 2K resolution streams or two, 4K resolution streams. All models can decode more streams at lower resolutions.

All Zio video wall processors provide instantaneous switching between streams and synchronization on up to 16 DisplayPort outputs, depending on the model.

Back Panels: Back panel images for Zio products are located in the Product Matrix beginning on page 40.

Options: Zio encoders, decoders and D2000 Series multiviewers are compatible with the Zio RAK and PDU 400-12 Power Distribution Unit. Refer to page 34 for detailed information.

VIDEO WALL PROCESSORS

Video wall processors enable the display of multiple sources across a tiled array of monitors or a blended array of projectors. RGB Spectrum features three lines of video wall processors: Galileo, MediaWall, and Zio Display Processors. For back panel graphics, please refer to page 41. For detailed technical specifications, dimensions and drawings, please refer to individual products pages at www.rgb.com/products. For information on Zio Display Processors, please refer to page page 26.

MEDIAWALL DISPLAY PROCESSORS

RGB Spectrum's MediaWall Display Processors enable the display of multiple windows across an array of monitors, or a blended array of projectors. The system is designed to deliver each input to the display wall uninterrupted and at full frame rates in real time, with no dropped frames, regardless of the number of inputs being presented.

The MediaWall processor is ready to use "out-of-the-box." Plug in the inputs, plug in the outputs, plug in the power, and turn it on; in minutes, the display wall will be ready to show images.

Because the MediaWall processor uses an embedded operating system, it is insulated from IP network intrusion. There is no access for hackers, and there's no need for anti-virus software. Also, the processors have no disk drive that can crash or be compromised, and no video is stored on-board.

Inputs are displayed in windows which can be located anywhere on the multi-screen display, without limitation. The processor's web-based GUI enables control of positioning and sizing. Pre-defined window layouts are available for instant wall configurations, which provide a great starting point for getting the MediaWall up and running. All custom configurations can also be saved as presets for future use.

MediaWall processors set no limits on display options; the multi-screen array forms a unified display surface on which any configuration of windows can be output.

Unique among video wall processors, firmware upgrades for the MediaWall can be downloaded while the unit is running, and updating the system takes only a quick moment to reboot, with virtually no downtime.

MediaWall processors are available with HDCP compliance to handle protected content. The processors also offer bezel compensation for LCD displays, and edge-blending support for projectors.

MEDIAWALL V DISPLAY PROCESSOR

Product Link

RGB Spectrum's MediaWall V Display Processor offers up to 4K resolution I/O, single-wire connectivity and fully scalable windows. The processor's unique hybrid architecture combines the reliability of a hardware-based processor with the flexibility of a separate, dedicated processor for running applications. With integrated IP capabilities, enhanced security, and an easy-to-operate control interface, the MediaWall V is a 4K video wall processing system with unsurpassed power and versatility.

The MediaWall V processor supports up to 36 video/graphic direct inputs and up to 28 outputs/display devices. It processes a full range of I/O resolutions including 4K UHD (3840 x 2160), 2K (2048 x 1152/1080), and HD (1920 x 1080). Inputs are fully scalable for output to a 4K video wall or for display on standard resolution video walls. An optional Application Processor (AP) decodes IP camera and other H.264 streams. HDCP capability allows the display of protected content.

The processor can display any configuration of window layouts across a multi-screen video wall array. Windows can be put anywhere, in any size, within or across screen boundaries, in any aspect ratio and zoomed in to emphasize details. Signal switching and preset layout recall are fast and seamless.

The MediaWall V web interface supports local and/or remote access, "drag and drop" window positioning and scaling, wall layout presets, and input selection. Our VIEW Controller graphical interface adds live thumbnails to enhance system operation. The processor can also be controlled by a variety of third-party devices. For the ultimate in flexibility, the MediaWall V processor is compatible with RGB Spectrum's MultiPoint Enterprise Control Room Management System (MCMS).

The versatile MediaWall V processor can control a video wall plus auxiliary monitors or even multiple video walls. It is ideal for simulation & training, modeling, high-resolution video surveillance, and other graphically-rich applications. In addition, when used with 4K projectors, the processor's edge-blending support can generate immersive, whole-room 4K displays for museums, theaters, auditoriums and a range of other venues.

MEDIAWALL 1900 AND 2900 DISPLAY PROCESSORS

Product Link

The MediaWall 1900 Display Processor accepts up to 24 input signals and outputs two DVI single-link signals. It can configure and display any 8 graphic or HD video sources on a linear 1x2 array of monitors or two edge-blended projectors.

The MediaWall 2900 Display Processor also accepts up to 24 input signals but outputs four DVI single-link or optional two DVI dual-link signals. It can configure 8 graphic or HD video input signals for display on many different monitor and projector arrays, including 1x3, 1x4, and 2x2.

Images can be displayed anywhere, at any size, within or across screens, in correct aspect ratio or stretched to fit the screen. Images can also be zoomed in to emphasize details. Output resolution for both processors can be adjusted up to 1920x1200 pixels, HD to 2048x1080 pixels; the optional DVI dual-link output for the 2900 processor supports up to 2560x1600 pixels.

MediaWall 1900/2900 processors provide DVI, HDMI, and RGB inputs, and support graphic signals up to 1920x1200 pixels and HD inputs up to 2048x1152 pixels.

The processors also offer bezel compensation for LCD displays, and edge-blending support for projectors.

GALILEO DISPLAY PROCESSOR

Product Link

The Galileo™ Display Processor combines the benefits of PC-based systems, such as IP inputs and the ability to run applications natively on the processor, with the 24/7 level of reliability and real-time performance of all of RGB Spectrum's solutions.

The video wall system supports a full range of input and output types (IP, analog, DVI, HDMI, DP, 3G/HD-SDI) with resolutions up to 4096x2160 at 60Hz. Inputs can be displayed in an unlimited number of windows located anywhere on the video wall. The processor can also display HDCP protected content.

The Galileo processor is available in several chassis sizes with varying input/output capabilities. Depending on the input cards chosen, each chassis can support a mix of digital and analog input signals.

The Galileo processor offers integrated multicast remote desktop functionality. This allows any authorized client to view and control another client or remote KVM host computer. Clients can also place remote KVM hosts onto the video wall for collaborative viewing.

The processor also supports IP stream decodes and playback of media files directly on the chassis. When using Zio encoders, the Galileo processor can automatically discover streams across the Zio network making it simple and quick to add Zio IP decodes to the video wall system.

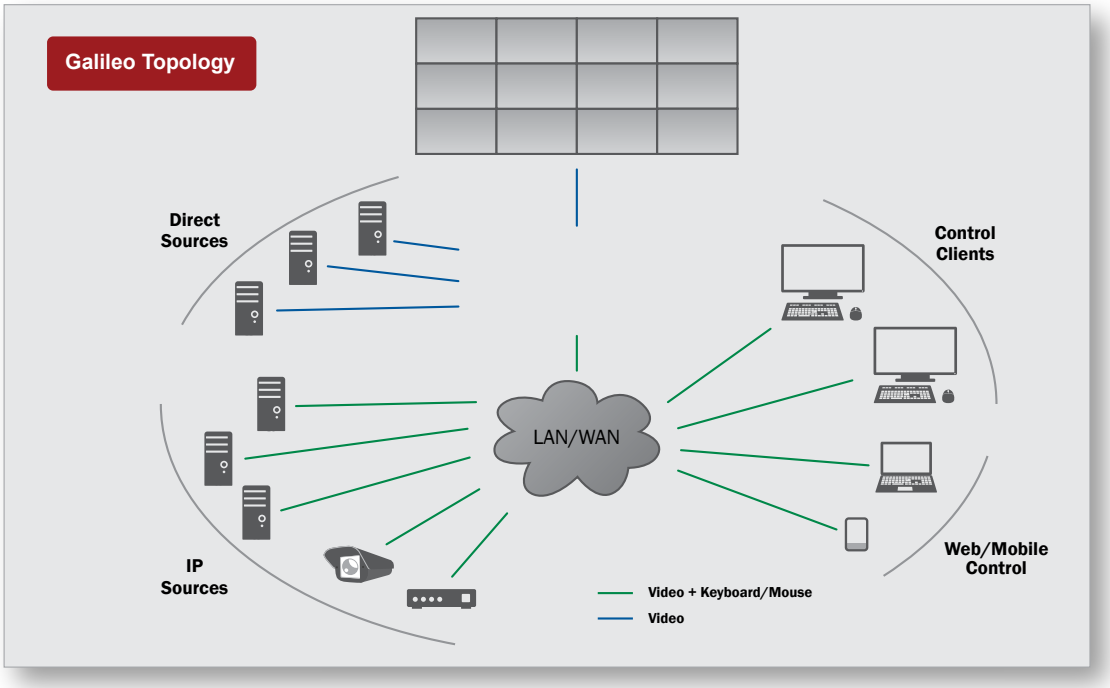
The Galileo system is easy to set up and control. An advanced GUI allows users to "drag and drop" inputs and applications, such as VMS, SCADA and videoconferencing, to the video wall. A built-in web interface, accessible from any computer, tablet or mobile device, enables users to recall layouts, move/resize windows, or recall scripts. No app is required! In addition, an API allows operators to create advanced scripts to recall layouts and control external, third-party equipment.

Outputs from the Galileo display processor can be arranged into separate surfaces to be used as multiple walls and auxiliary or desktop displays not part of a wall. This flexibility provides more value from a single chassis.

Digital Signage Feartures

With the Advanced software package, the Galileo Display Processor can perform the demanding graphics manipulation required for digital signage applications. Users can create compelling signage displays using a variety of transition effects on baseband video inputs.

The timeline-based transition editor allows users to easily set and change the following window parameters: position, cropping, opacity, rotation, rotation point, input, brightness, contrast, hue, and saturation. Once programmed, these effects can be recalled from a PC, tablet or even mobile phone, through the Galileo control interface. Transitions can also be scheduled to repeat at regular intervals.



Security Features

The Advanced software package offers enhanced features to protect the integrity of system data and resources. Designed for multi-user environments, the security option lets administrators define user profiles and control access to specific system functions (e.g. access to sources, recalling a layout, etc.). This package is ideal for IT managers who require the added security of user-definable privileges, Microsoft Active Directory authentication, and event logging.

The following security-based features are part of the Advanced software package:

User Profile Manager:

- Authenticates users through Active Directory
- Manages users, groups and access privileges
- Restricts working area for specific users
- Limits user access to schedules, layouts, and scripts

Security Log:

- Keeps a record of login and logout events
- Logs window positions and records who is moving them
- Logs when schedules, layouts, and scripts are created, modified or deleted
- Offers administrators the ability to customize the logs

The Galileo processor is ideal for a range of applications including mission-critical operations/command centers and control rooms, as well as boardroom video walls, corporate lobby displays, and large-scale digital signage.

RGB Controllers: Please refer to page 22 for information on VIEW Controllers.

Back Panels: Back panel images for video wall processors are located in the Product Matrix beginning on page 41.

Options: MediaWall and Galileo products are compatible with XtendView FiberDVI Adapters, and CAT-Linx 2 HDBaseT Extenders. Refer to page 34 for detailed information.

MULTIVIEWERS

RGB Spectrum's multiviewer products excel in their ability to display up to 8 video and computer sources on a single display device (i.e. monitor or projector) at high resolution. All incoming video signals are processed in parallel and without processing delays, at original resolution, color depth, frame rate and color sampling rate. This results in the highest quality, "source authentic" video experience possible. All RGB Spectrum multiviewers are based on a dedicated, non-PC system architecture and provide enhanced security and reliability through an embedded operating system.

Multiviewers include a Web Control Panel (WCP), and all models support IP and RS-232 control. To further simply operation, the QuadView UHD also offers front-panel and infrared (IR) remote controls.

QUADVIEW UHD MULTIVIEWER

Product Link

RGB Spectrum's QuadView UHD Multiviewer is a high-performance multi-image processor that simultaneously displays up to four, 4K (or lower resolution) sources in a variety of layouts.

Simply connect the QuadView UHD multiviewer to any monitor from XGA up to UHD resolution to experience the next generation in multiviewer performance. With the QuadView UHD, you can mix and match input resolutions, scale video inputs up to 4K UHD and route any of the seven inputs to any window. Powerful image processing capabilities allow the multiviewer to simultaneously display both HD and UHD inputs without downscaling. 16 standard window layouts are provided — including quad-split, full screen, triple-window, side-by-side, and picture-in-picture modes.

The multiviewer includes HDCP authentication and EDID management functionality, as well as the ability to switch inputs. An audio breakaway feature allows you to select audio from any source — even one not currently displayed.

The QuadView UHD's intuitive front panel lets you quickly select audio, input, and layout options. Simply choose a layout, choose a window, and then select an input. Third-party control is possible through Ethernet or RS-232 and is supported with a comprehensive API.

SUPERVIEW 4100 MULTIVIEWER

Product Link

The SuperView® 4100 Multiviewer can display up to eight graphic or HD video sources on a single monitor or projector. Images can be displayed anywhere, in any size, in smaller windows or full screen, with pan and zoom capabilities.

The processor provides DVI, HDMI, 3G/HD-SDI, and RGB inputs for up to eight windows, and features DVI single-link and DVI dual-link outputs. The output timings can be adjusted to match the native resolution of any display device, up to 1920x1200 pixels or 2048x1080 pixels, and DVI dual-link up to 2560x1600 pixels.

SUPERVIEW 4K MULTIVIEWER

Product Link

The SuperView 4K multiviewer is designed for Ultra HD (UHD) displays and projectors that have resolutions of eight megapixels — four times the resolution of HD video. Based on RGB Spectrum's real-time architecture, the SuperView 4K gives you the ability to display and manipulate native 4K images, a combination of 4K and high-definition (1920x1080) windows, or up to eight HD graphic or video windows (scaled or unscaled) on a single UHD display device. The result is a remarkable eight-megapixel multiviewer, with unprecedented multi-window clarity and resolution.

The processor offers fast video updates, high display flexibility, and high security. Real-time display of all inputs is guaranteed under all conditions.

The multiviewer provides a full array of features, including dynamic window sizing and positioning, input grouping, panning and zooming within images, custom borders, titles, HDCP support, and programmable presets. Images can be arranged anywhere on an Ultra HD display, in any size, in standard or custom aspect ratios, with or without overlaps, and with any desired priority. Options include a redundant power supply. A full range of graphic, HD and Ultra HD resolutions are supported.

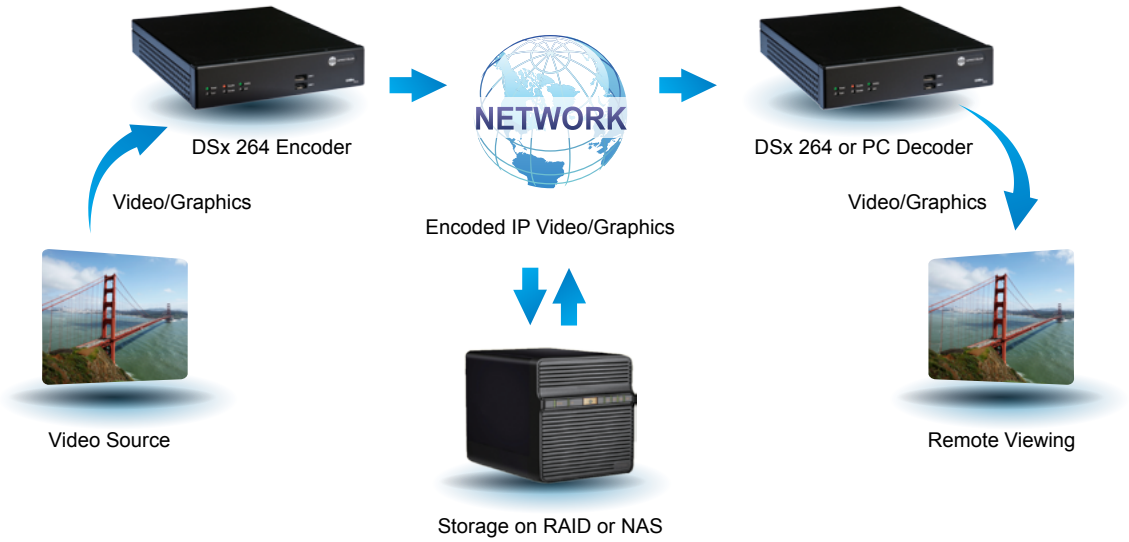
The SuperView 4K multiviewer connects to UHD displays and projectors using four, single-link DVI connectors or two, DVI dual-link connectors.

Back Panels: Back panel graphics for QuadView and SuperView multiviewers are located in the Product Matrix on page 41.

Options: QuadView and SuperView multiviewers are compatible with DSx 264 Decoders (see page 31), XtendView FiberDVI Adapters, and CAT-Linx 2 HDBaseT Extenders. Please (see page 34).

RECORDING/STREAMING CODECS

RGB Spectrum offers a complete line of products for streaming and recording H.264 and JPEG2000 compressed video. They support graphics/video resolutions up to 1920x1200 and all HD rates. State-of-the-art DSx codecs use advanced H.264 ***High*** Profile compression technology which produces superior image quality as compared to the more conventional Main and Baseline Profiles used in other codecs. DGy JPEG2000 codecs provide visually lossless encoding for the most demanding applications.



Sample setup of a basic DSx codec system

DSx 264 CODEC

Product Link

RGB Spectrum's DSx 264 codecs provide an unmatched combination of superior image quality, high performance, and feature-packed capabilities, including exclusive features not found with any other codecs in the industry. The DSx 264 codec encodes and streams graphics and HD video at up to 1920x1200 resolution, using H.264 *High* Profile compression. The codec's recording and replay options offer the ability to store data on a local USB storage device or an external Network Attached Storage (NAS) device, such as a RAID or server. The DSx 264 also offers the innovative ability to simultaneously stream while recording.

IP streams can be decoded with commercial off-the-shelf PC software, or, where very low latency is required, other DSx codecs can be used.

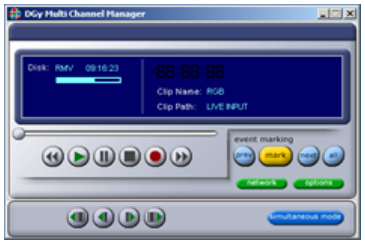
Advanced features include on-screen display (OSD), external time code synchronization, event marking, variable speed playback, random access, confidence monitoring, and a unique failsafe feature that automatically protects recordings in case of catastrophic system failure.

The DSx 264D decoder is also available which has stream decoding and recording replay capabilities.

DSx and DGy codecs are integrated into the systems of many military pilot training programs

Multi-Channel Operation

DSx and DGy codecs can be interconnected to support multi-channel concurrent recording, streaming, and replay. The Multi Channel Manager™ (MCM) is a stand-alone software package that simultaneously controls multiple codecs. The MCM control panel is an intuitive GUI that is easy to use with minimal learning time.



- Concurrently controls multiple codecs for multi-channel recording, playback, & streaming
- Controls up to 32 interconnected codecs from a single control panel
- Record and replay to/from remote NAS storage devices
- Place and randomly access Event Marks
- Loss of signal indicator

Remote Monitoring Capability

DSx codecs provide operators with the ability to remotely view the real-time output of a centralized display using their own PCs and a software decoder. This powerful feature allows live remote viewing of information in any part of a facility and beyond, and enables you to “Take Your Display Anywhere.”

DSx Codec used as part of a remote monitoring system

DGy JPEG2000 CODEC

Product Link

The DGy family of JPEG2000 codecs record, transmit, and stream at up to 1920x1200 pixel resolution. JPEG2000 compression technology allows these codecs to deliver visually lossless digital recording and streaming.

DGy codecs support recording and streaming of computer, radar, sonar, FLIR, X-Ray, and HD signals, plus stereo audio. External network attached storage devices, such as a RAID server, are used to offer virtually unlimited capacity.

DGy codecs offer an unparalleled feature set, including external time code synchronization (IRIG-B or Network Time Server), event marking, variable speed playback, and frame-by-frame jog/shuttle. A unique simultaneous record/replay option allows the review of imagery while recording is in process. A failsafe feature automatically protects recordings in case of catastrophic system failure.

Multiple units can be interconnected to support simultaneous recording of multiple channels. Operation is simple and intuitive using an embedded web-based graphical user interface. Codecs can also be operated using third-party controllers.

Superb image quality, a rich feature set, and outstanding performance makes DGy codecs the ideal recording and streaming solution for demanding mission-critical applications.

Options: DSx and DGy Codecs are compatible with XtendView FiberDVI Adapters and CAT-Linx 2 HDBaseT Extenders. Please refer to page 34 for more details on these products.

MATRIX SWITCHERS

Matrix switchers are the backbone of audiovisual systems because they route the outputs of computers and other image sources to the displays in a room.

LINX MATRIX SWITCHER

Product Link

RGB Spectrum's Linx Matrix Switcher is available in three chassis sizes up to 32 inputs x 32 outputs, and offers a choice of signal connection with copper, fiber, or HDBaseT I/O cards. 3G/HD-SDI inputs are also accommodated. The intuitive Web Control Panel provides a sophisticated set of tools to simplify setup and operation. This includes EDID and HDCP management, the ability to import and export settings, signal indicators, built-in signal diagnostics, and color space conversion. With RGB Spectrum's *Total EDID Manager*, EDID files can be exchanged between the switcher and a PC, and edited to allow the creation of custom EDID files.

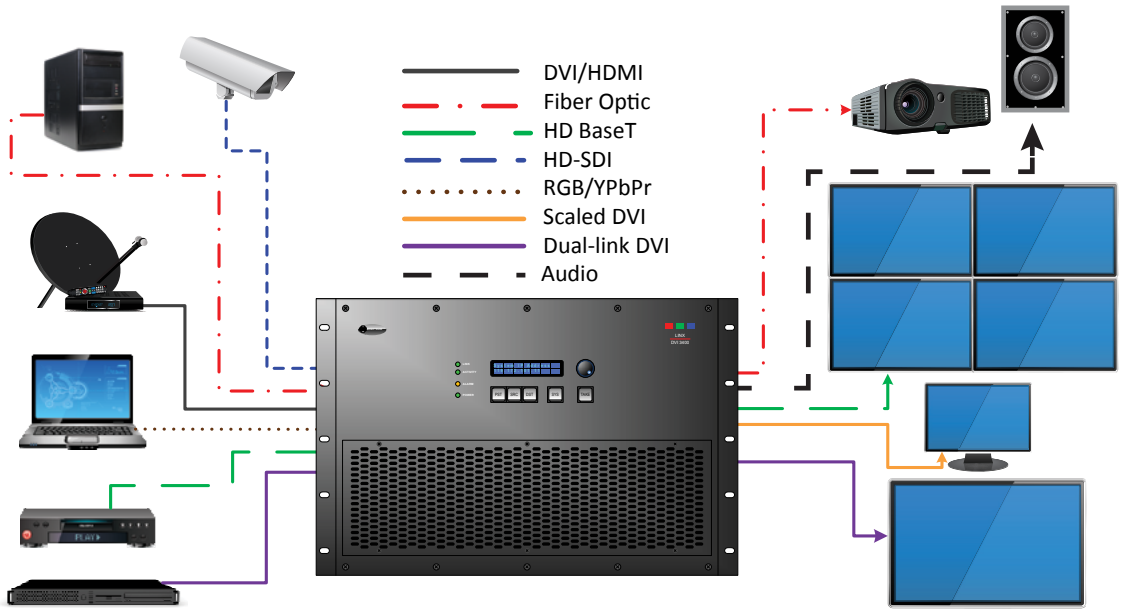
HDCP support, including audio passthrough, allows Linx switchers to accommodate content-protected HDMI signals. An HDCP signal can be routed to all outputs simultaneously, regardless of source device key limitations.

All Linx matrix switchers feature:

- Fast switching
- Color space conversion
- Force hot plug (initiates fresh EDID read by source)
- 4:2:2/4:4:4 up/down sampling
- Support for copper DVI input cables up to 165 feet
- HDCP ON/OFF for each DVI input
- HDCP-compliant single-strand fiber solution (compact headshell form)
- Ability to create and save custom timings for analog in and scaler out
- User-swappable cards and power supplies
- Audio de-embedding

Incorporating RGB Spectrum's CrossXFormat® architecture, Linx switchers support DVI, HDMI, RGB or component signals on every input. Analog RGB or component inputs are internally converted, processed through the switcher, and output as DVI signals. Users can create and save custom timings to accommodate sources with non-standard timings.

DVI input and output cards offer the option of dual-link DVI connections, which can support pixel clock rates of up to 330 MHz. Input cards support one DVI dual-link, or two DVI single-link/analog RGB channels. DVI output cards support one dual-link DVI or two single-link DVI channels.



Sample setup of a basic Linx Matrix Switcher system

Modular input and output cards for the Linx switcher accommodate a broad range of signal types, copper and fiber I/O, and offer scaling and seamless switching.

Input cards include: DVI / HDMI,DVI / HDMI + RGB, 3G/HD-SDI, Fiber DVI / HDMI, and HDBaseT.

Output cards include: DVI, DVI with Scaling, HDMI + Audio, Fiber DVI / HDMI, and HDBaseT.

DVI with Scaling output cards allow input signals to be scaled to custom timings to accommodate any specific display requirement. A scaling card set to output a continuous sync provides faster switching, regardless of changes in input signal type or timing.

Pan and zoom features add flexibility for applications that require the ability to view portions of images in more detail.

Fiber DVI / HDMI input and output cards offer full-bandwidth transmission of high pixel clock signals without any compression, dropped pixels, or loss of color depth. High-resolution graphic or video signals can be transmitted up to 400 meters over a single strand of multimode cable.

In addition to high-resolution video, a supplemental bidirectional channel supports the Display Data Channel (DDC). This allows the system to take advantage of advanced EDID management capabilities, including EDID capture and EDID passthrough. HDCP compliance allows the switching and transmission of protected content. Each user-swappable input or output card features two independent channels.

HDBaseT I/O Cards and Endpoints

CAT-Linx™ HDBaseT input and output cards support HDMI and DVI with local serial RS-232 extensions up to 150 meters. CAT-Linx 2 HDBaseT Transmit (TX) and Receive (RX) Endpoints work with Linx HDBaseT I/O cards. They are HDCP-compliant and support HDMI with embedded audio and local serial data. CAT-Linx 2 TX and RX endpoints and other compatible devices can get 48 VDC of power directly from CAT-Linx cards over the same cable, eliminating the need for external power supplies.

Linx Audio Features

RGB Spectrum's HDMI + Audio output card can be installed in any available output slot of a Linx switcher chassis and is HDCP-compliant to ensure protection of digital content. It transmits pristine HDMI signals to display devices and decodes embedded digital audio from encrypted signal streams.

Audio is typically included as part of a source HDMI signal, such as a Blu-ray movie, or is added to other types of video signals by external devices such as our VIA-300 Audio Embedder. The HDMI + Audio card features two independent channels which each de-embed stereo audio from incoming signal streams. Once separated, the de-embedded audio is available on an easy-to-wire, removable terminal block as either a balanced or unbalanced analog signal.

The card utilizes HDMI connectors and supports resolutions up to 2048x1152 and 1920x1200 p60. Additional features include channel select, mute and mono settings, and data reclocking.

Total EDID Manager

RGB Spectrum's Total EDID Manager™ works with Linx Matrix Switchers to offer a complete set of EDID management tools. Total EDID Manager provides:

- Fixed, emulated and real-time EDID passthrough
- Arbitration schemes for switching an input signal to monitors of differing resolutions
- EDID capture and storage for up to 100 files, with assignment to inputs or outputs
- Import and export of EDID files for editing and storage
- Protection against graphics card shutdown after a hot plug event

All functions are controlled with an intuitive browser-based GUI or by serial commands via Telnet or RS-232. Total EDID Manager also eliminates the need for external EDID emulators.

Back Panels: Back panel images of the different models of Linx switchers are located in the Product Matrix on page 43.

Options: Linx switchers are compatible with XtendView FiberDVI Adapters and CAT-Linx 2 HDBaseT Extenders. Please see details on page 34.

EXTENDERS AND ACCESSORIES

CAT-LINX 2 HDBASET EXTENDERS

Product Link

CAT-Linx 2 extenders transmit signals up to 4K Ultra HD at 60Hz using conventional CAT 5e/6 cable. CAT-Linx 2 units can transmit HD signals up to 100 meters and 4K Ultra HD signals up to 70 meters. Transmit (TX) and Receive (RX) endpoints are compatible with all RGB Spectrum wall processors, multiviewers, switchers, and AV devices from other manufacturers.

For installation ease and convenience, CAT-Linx 2 extenders have integrated power (PoH) to supply endpoints over the same CAT5e/6 cable that carries the video and data signals. This eliminates the need for external power connections.

CAT-Linx 2 extenders offer a bevy of advanced features, including HDCP 2.2, Dolby and DTS HD audio support, and serial and IR control of display devices. Bidirectional RS-232 signal transmission between endpoints is also available for serial control of sources or display devices.

CAT-Linx 2 extenders meet the specifications of the HDBaseT Alliance and are compatible with other HDBaseT-certified products. A mounting rack which holds 12 RX or TX units is available. CAT-Linx 2 HDBaseT extenders are a high performance, feature-rich, and cost-effective solution for signal distribution, for both small-scale and large-scale installations.

XTENDVIEW FIBERDVI ADAPTERS

Product Link

RGB Spectrum's XtendView® FiberDVI extenders are a compact, long-range signal extension solution that transmits data up to 1300 feet (400m) over a single strand of fiber optic cable.

The XtendView system consists of transmit (TX) and receive (RX) plug-in endpoints fitted with industry standard SC jacks for easy connection of fiber cables. The endpoints' innovative "all-in-the-headshell" system uses miniaturized electronics that fit entirely within the DVI connector housing, eliminating the need for external boxes and cables and greatly simplifying installation. XtendView TX/RX endpoints are compatible with all RGB Spectrum wall processors, multiviewers, switchers, and AV devices from other manufacturers.

XtendView endpoints feature an integrated data channel that supports real-time EDID pass-through and HDCP. EDID and HDCP data are combined with the video, so only a single fiber is required. XtendView endpoints also support embedded audio in HDMI signals.

For further convenience and installation ease, XtendView TX endpoints may be powered externally or through pin power.

PDU 400-12 POWER DISTRIBUTION UNIT

Product Link

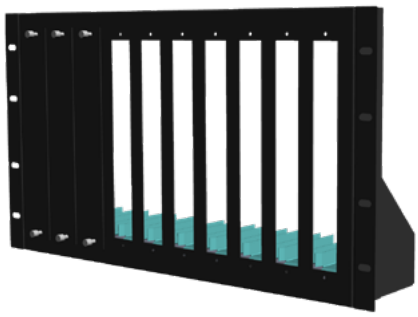
RGB Spectrum's Power Distribution Unit (PDU) makes it simpler, easier and faster than ever to power a variety of devices. Say goodbye to rack cable clutter and wall warts.

The convenient PDU 400-12 400-watt Power Distribution Unit provides 12 channels of 12-VDC power in a rugged, 1RU rack-mountable enclosure. It is designed for 24/7 reliability, allowing system designers and facility managers to optimize power management.

The PDU 400-12 auto-senses and accepts line voltages from 88 to 264 volts AC. It offers a unique, active Power Factor Correction (PFC) circuit that minimizes input current harmonics, enabling it to operate at very high efficiency. All outputs feature robust overload, over-voltage, and over-temperature protection.

The PDU 400-12 integrates with RGB Spectrum's Zio networked AV products, CAT-Linx 2 HDBaseT extenders, and AV devices from other manufacturers. Versatile and reliable Phoenix connectors allow for ease of use with a wide variety of devices that require 12-VDC power. Direct connectors are available for RGB Spectrum's Zio Encoders and Decoders and CAT-Linx 2 HDBaseT Extender products.

RAK MOUNTING ACCESSORY



Product Link

The CAT RAK and Zio RAK are rackmount shelves for up to 12 CAT-Linx 2 units or up to 10 Zio S2000/D2000 units. This convenient, 6RU-high shelf allows each endpoint to be securely mounted in a vertical orientation. The PDU 400-12 Power Distribution Unit mounts above or below to provide power directly to all endpoints mounted in the rack.

CASE STUDIES

APPLICATION	CUSTOMER	MARKET	PRODUCT
EOC Situation Monitoring Room	Hennepin County, Minnesota	Government Security	MediaWall 4500 QuadView UHD Multiviewer

OVERVIEW/CHALLENGE

Previously, there was no room in the facility that allowed operators to quickly display multiple visual data sources during a crisis or a training session.

SOLUTION

RGB Spectrum's MediaWall 4500 display processor allows the room to display up to 18 sources across a 1x4 Projector wall with a click of a button.

The QuadView Multiviewer allows the operator to recall any 4 sources to 60-inch LCD displays in separate situation monitoring rooms during potential emergencies.

For the integrator, quick installation, easy set up and quality of processing were the key benefits.

APPLICATION	CUSTOMER	MARKET	PRODUCT
Regional Operations Center	Bexar Metro 9-1-1 REOC	Government Security	Galileo MultiPoint Enterprise

OVERVIEW

The new Bexar Metro 9-1-1 Regional Operations Center unifies the emergency operations of three counties in a single, 13,878 square feet, cutting-edge facility.

CHALLENGE

Each county had their own facility, which impeded situational awareness and slowed communications in emergency situations.

SOLUTION

RGB Spectrum's MultiPoint Enterprise, Galileo wall processors, and Opto™ matrix switchers were installed to accommodate 104 operator consoles plus several large video walls. A wide array of source material can now be shared among the many stakeholders.

The flexibility to grow as needs change was a key reason they chose RGB Spectrum's solutions.

CASE STUDIES

APPLICATION	CUSTOMER	MARKET	PRODUCT
Simulation: UAV Operator Training	Northrop Grumman, Triton/Global Hawk UAV, Operator Ground Control Stations	Defense & Aerospace	DGy JPEG2000 Codec

OVERVIEW

UAV Ground Control Station (GCS) Operator Training system executes simulations for Triton and Global Hawk UAV operators. Each GCS is dual operator: one for flight control and navigation, the second for target acquisition and weapons control.

CHALLENGE

They needed a recording solution for trainee debriefing that precisely replicated the intricate detail of high-resolution visuals, including surveillance, navigation, avionics, target identification and weapons control.

SOLUTION

RGB Spectrum's DGy JPEG2000 codec, which delivers visually lossless recording. The DGy codec's leading-edge reproduction preserves the image quality of the original sources.

During the training scenarios, instructors can place event marks at any point in the recording which can be instantly accessed during debriefing with the trainees.

APPLICATION	CUSTOMER	MARKET	PRODUCT
Command Center	Cape Canaveral Air Force Station	Defense & Aerospace	MediaWall V Display Processor

OVERVIEW

Cape Canaveral's Morrell Operations Center (MOC) is the main command center for all missile and space launches from the Kennedy Space Center facilities, tracking space vehicles and missile tests and monitoring their performance.

CHALLENGE

To meet increasing launch support demand, the MOC is implementing a modernization effort to renovate the visual display systems in its two command rooms.

SOLUTION

Each of the MOC command rooms is equipped with RGB Spectrum's MediaWall V processor. The processors provide higher resolution and advanced video wall features, including integrated switching, multi-window display, overlapping images, and pan and zoom. Each processor drives two edge-blended projectors in a 1x2 array.

CASE STUDIES

APPLICATION	CUSTOMER	MARKET	PRODUCT
Auditorium & Classrooms	Washington University	Education	Linx Matrix Switcher Video Wall Processors

OVERVIEW

The existing A/V control room was to be transformed into a centralized facility to manage and distribute visual content from a wide variety of sources to multiple facilities.

CHALLENGE

Prior to installation, classrooms were independent and unconnected, which resulted in redundant hardware, poor productivity as well as staff having to move from classroom to classroom.

SOLUTION

The IT manager now uses RGB Spectrum's matrix switchers and wall processors for high performance and low latency distribution of multiple sources to multiple classrooms from the central operation center.

The result is a streamlined educational system allowing better use of facility resources and personnel.

APPLICATION	CUSTOMER	MARKET	PRODUCT
Control Room	Statoil, Norway	Oil & Gas	MediaWall Display Processors

OVERVIEW

Statoil's offshore oil drilling platform control rooms manage over 50 oil and gas fields on the Norwegian continental shelf. These control rooms manage sites to ensure security, prevent accidents and respond to emergencies. Statoil has been executing a long-term display technology upgrade in these control rooms.

CHALLENGE

Statoil required the highest performance, mission critical video wall processing technology with 24/7 reliability.

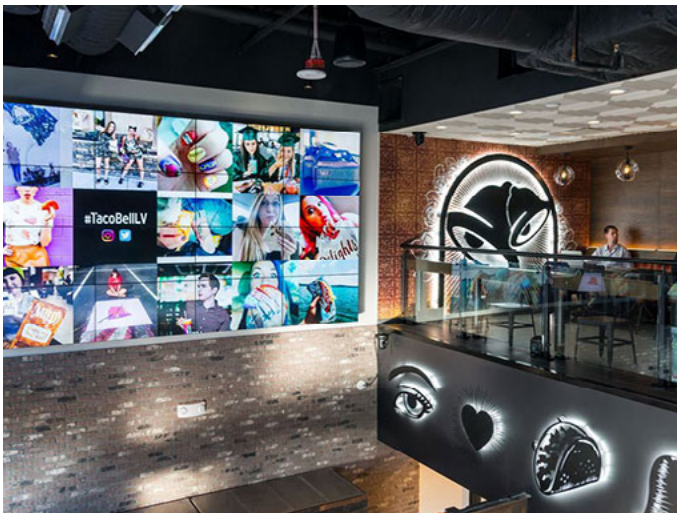
SOLUTION

RGB Spectrum's MediaWall line of video wall processors have been installed in these control rooms for nearly a decade. The latest processor, MediaWall V, brings advanced 4K UHD display capability. The rooms have varying configurations of 4 to 8 projectors.

MediaWall's embedded architecture assures real-time signal throughput with no PC-based vulnerabilities.

CASE STUDIES

APPLICATION	CUSTOMER	MARKET	PRODUCT
Digital Signage: Entertainment	Taco Bell	Corporate	MediaWall V Display Processor



OVERVIEW

Taco Bell is expanding in a bold, innovative way with the launch of its new "Cantina" restaurant concept. The new, two-story flagship Cantina, located on Las Vegas's popular Strip, features a novel combination of entertainment, expanded menu, and adult beverages.

CHALLENGE

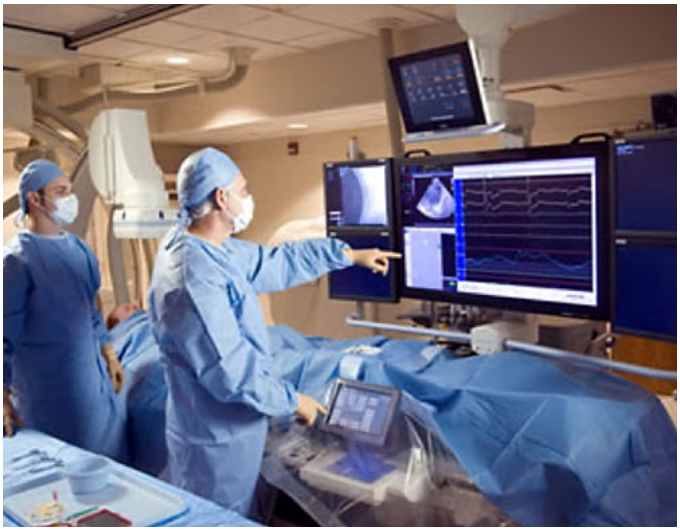
Engage, captivate and entertain patrons as they browse, order and dine using a large video wall for a fun, social dining experience.

SOLUTION

RGB Spectrum's MediaWall V processor drives the Cantina's massive 14-foot by 8-foot 4x4 video wall. The MediaWall displays live-streamed broadcast, sporting, and news events, and social media.

MediaWall's embedded processing architecture delivers exceptional 24/7 reliability for the high-traffic, high-visibility installation. It displays imagery in windows of any size, anywhere on the video wall canvas to enhance the entertainment experience.

APPLICATION	CUSTOMER	MARKET	PRODUCT
Catheterization Lab	Major Medical Center	Medical	Multiviewers



OVERVIEW

A catheterization lab in a leading medical center brought together a host of advanced video and medical equipment to ensure each patient receives effective diagnosis and treatment in the quickest time possible.

CHALLENGE

Operating room personnel needed flawless image processing with no dropped frames in a highly reliable video monitoring solution.

SOLUTION

RGB's multiviewer enables medical personnel to view a variety of sources in real time. Diagnostic imaging equipment, catheterization devices, surgical light cameras, endoscopic cameras, computer servers, and network stored images are shown in multiple windows on a single display.

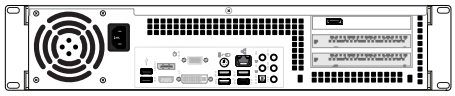
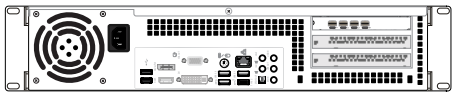
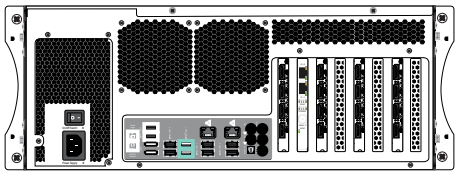
Additionally, the embedded processor ensures 24/7 reliability with no down time.

PRODUCT MATRIX

The following section contains back panel illustrations and basic information related to inputs and outputs for RGB Spectrum multiviewers, video wall processors, and matrix switchers. For more detailed information and exact dimensions, please refer to technical specifications and drawings on the product pages of our website at www.rgb.com.

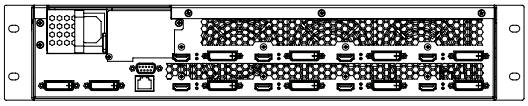
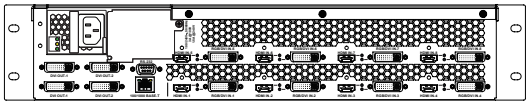
NETWORKED AV

ZIO ENCODERS, DECODERS, MULTIVIEWERS AND WALL PROCESSORS

Model	Rear Panel Layout (not to scale)	Inputs	Windows	Outputs
		Number / Type	Total #	Number / Type
Zio S2000 Encoder		1 HDMI		1 RJ-45 1 HDMI pass-through
Zio D2000 Decoder		1 RJ-45		1 HDMI
Zio D2000 Multiviewer		1 RJ-45	Unlimited	1 HDMI
Zio D3124 Multiviewer		1 RJ-45	Unlimited	1 DisplayPort
Zio D3062 Wall Processor		1 RJ-45	Unlimited	4 MiniDisplayPort
Zio D3100 Series Wall Processor		1 RJ-45	Unlimited	up to 16 DisplayPort

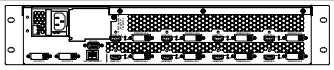
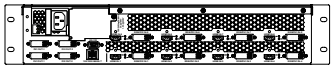
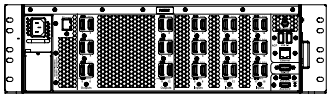
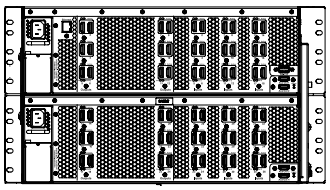
MULTIVIEWERS

QUADVIEW AND SUPERVIEW

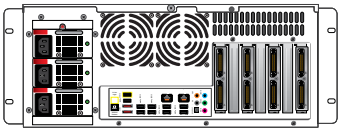
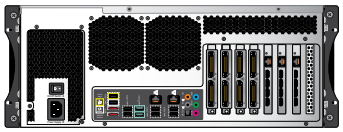
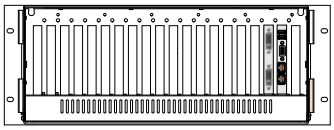
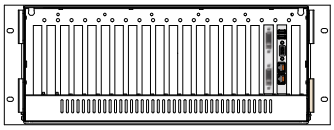
Model	Rear Panel Layout	Inputs			Windows	Outputs
		Max	Number / Type per Card	Max Cards	Total #	#
QuadView UHD		7 Video 7 Audio	4x HDMI (4K) 2x Display Port (4K) 1x RGB	Fixed	4	1
SuperView 4100		24	8x DVI Digital 8x RGB Analog 8x HDMI	Fixed	8	1 + 1 Duplicated Dual-link Output Option Available
SuperView 4K		24	8x DVI Digital 8x RGB Analog 8x HDMI (1.3)	Fixed		4 DVI

VIDEO WALL PROCESSORS

MEDIAWALL

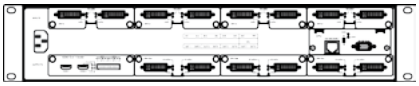
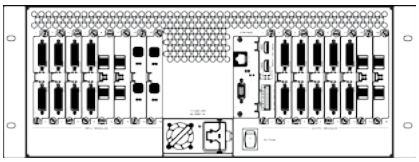
Model	Rear Panel Layout	Inputs			Windows	Outputs		
		Max	Number / Type per Card	Max Cards	Max	Max Cards	Max	Configurations (HxW)
MediaWall 1900		24	8x DVI Digital 8x RGB Analog 8x HDMI	Fixed	8	Fixed	2	1x2
MediaWall 2900		24	8x DVI Digital 8x RGB Analog 8x HDMI	Fixed	8	Fixed	4	1x2 - 1x4 2x1 - 2x2 Dual-link Output Option Available
MediaWall V (3RU)		18	6x HDMI	3	32	2	12 (2K)	1x2 - 1x12 2x2 - 2x6; 3x3, 4x3
							6 (4K@30Hz) 2 (4K@60Hz)	1x3 - 1x6 2x2, 2x3
MediaWall V (6RU)		36	6x HDMI	6	64	4	24 (2K)	1x2 - 1x24 2x2 - 2x12 3x3 - 3x8 4x6
							12 (4K@30Hz) 4 (4K@60Hz)	1x2 - 1x12 2x2 - 2x6 3x3, 4x3

GALILEO

Model	Rear Panel Layout	Inputs			Windows	Outputs		
		Max	Number / Type per Card	Max Cards	Max	Max Cards	Max	Configurations (HxW)
Galileo 16		16 Digital/ Analog	4x DVI / HDMI + Analog RGB 4x HDMI 2x DVI / HDMI	**4**	Unlimited	**4**	**16**	Unlimited up to available outputs
		48 Analog	2x 3G/HD-SDI 8x Analog 16x Analog					
		Unlimited	IP Inputs Applications	N/A				
Galileo 28		24 Digital/ Analog	4x DVI / HDMI + Analog RGB 4x HDMI 2x DVI / HDMI 2x 3G/HD-SDI	**6**	Unlimited	**6**	**24**	Unlimited up to available outputs
		80 Analog	8x Analog 16x Analog					
		Unlimited	IP Inputs Applications	N/A				
Galileo 40		40 Digital/ Analog	4x DVI / HDMI + Analog RGB 4x HDMI 2x DVI / HDMI 2x 3G/HD-SDI	**10**	Unlimited	**10**	**40**	Unlimited up to available outputs
		160 Analog	8x Analog 16x Analog					
		Unlimited	IP Inputs Applications	N/A				
Galileo 56		56 Digital/ Analog	4x DVI / HDMI + Analog RGB 4x HDMI 2x DVI / HDMI 2x 3G/HD-SDI	**14**	Unlimited	**14**	**56**	Unlimited up to available outputs
		272 Analog	8x Analog 16x Analog					
		Unlimited	IP Inputs Applications	N/A				

MATRIX SWITCHERS

LINX

Model	Rear Panel Layout	Inputs			Outputs		
		Max	Number / Type per Card	Max Cards	Max	Number / Type per Card	Max Cards
Linx 1000		8	2x DVI / HDMI + Analog RGB 2x Fiber DVI/HDMI 2x 3G/HD-SDI 1x Dual-link DVI	4	8	2x DVI / HDMI 2x DVI w/Scaler 2x Fiber DVI/HDMI 2x HDMI/Audio 1x Dual-link DVI	4
Linx 1800		16	2x DVI / HDMI + Analog RGB 2x Fiber DVI/HDMI 2x 3G/HD-SDI 1x Dual-link DVI	8	16	2x DVI / HDMI 2x DVI w/Scaler 2x Fiber DVI/HDMI 2x HDMI/Audio 1x Dual-link DVI	8

DESIGN SERVICES

WHAT WE OFFER

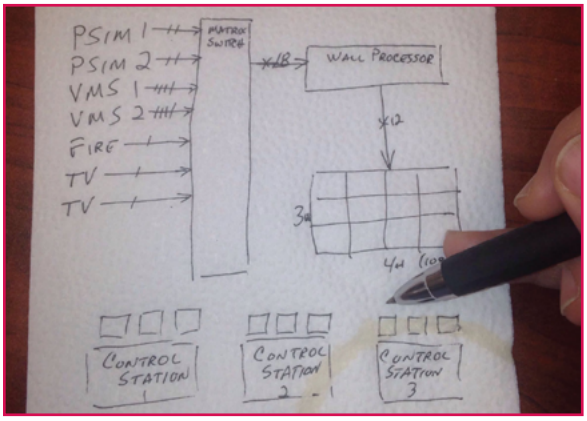
RGB Spectrum's design services program provides complimentary system consulting to better meet the needs of our valued partners and customers worldwide.

As part of our expanded Technical Services department, a team of highly-qualified applications engineers will provide custom-designed system solutions for specific projects.

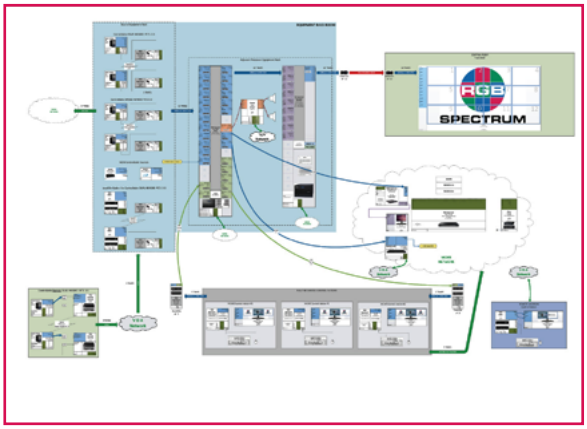
To start the design process, contact your Regional Sales Manager or go to www.rgb.com/design-services.

The following sample system diagrams provide examples of the work our Design Services team provides to assist consultants, integrators, and dealers in specifying RGB Spectrum solutions.

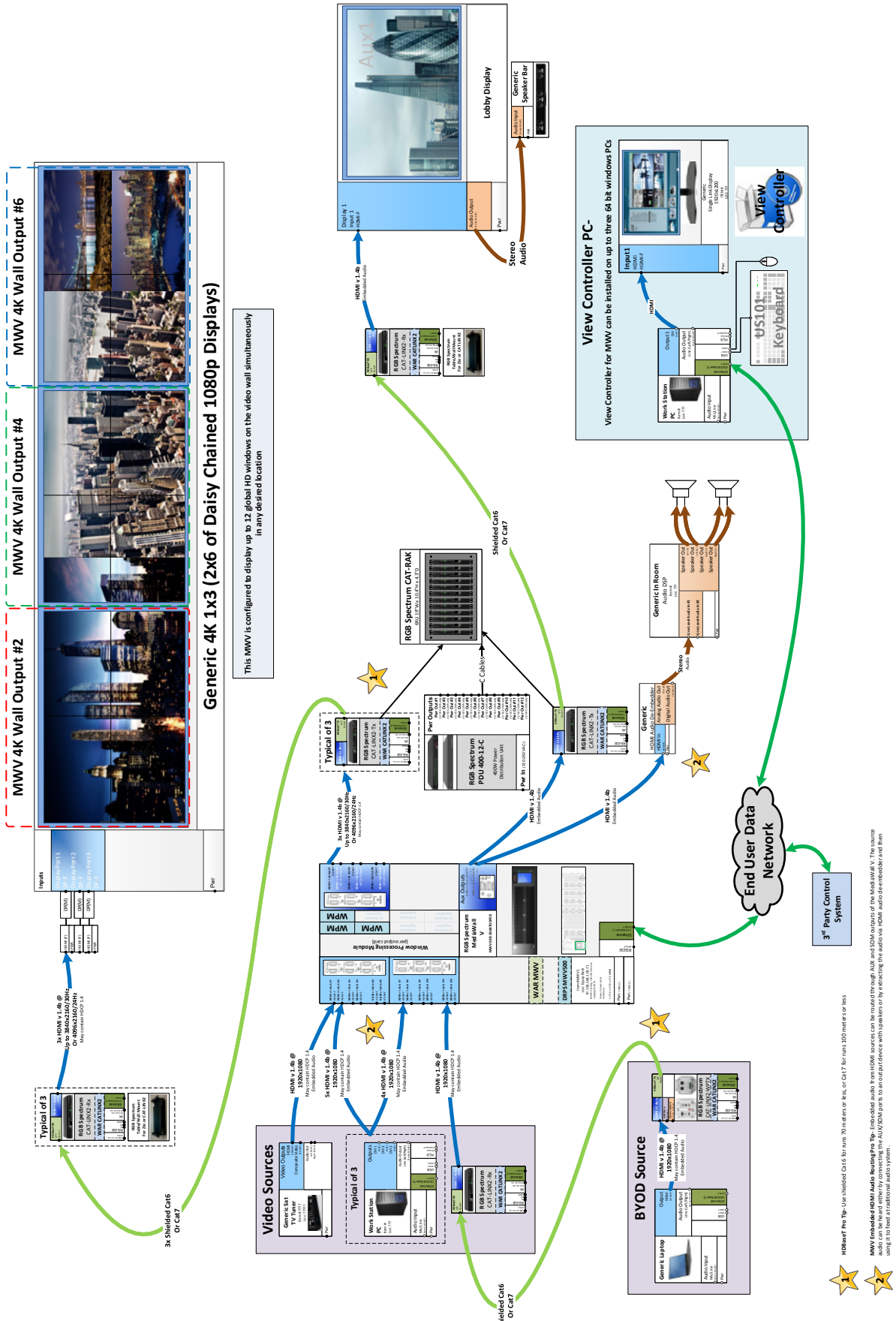
From Concept



To Design



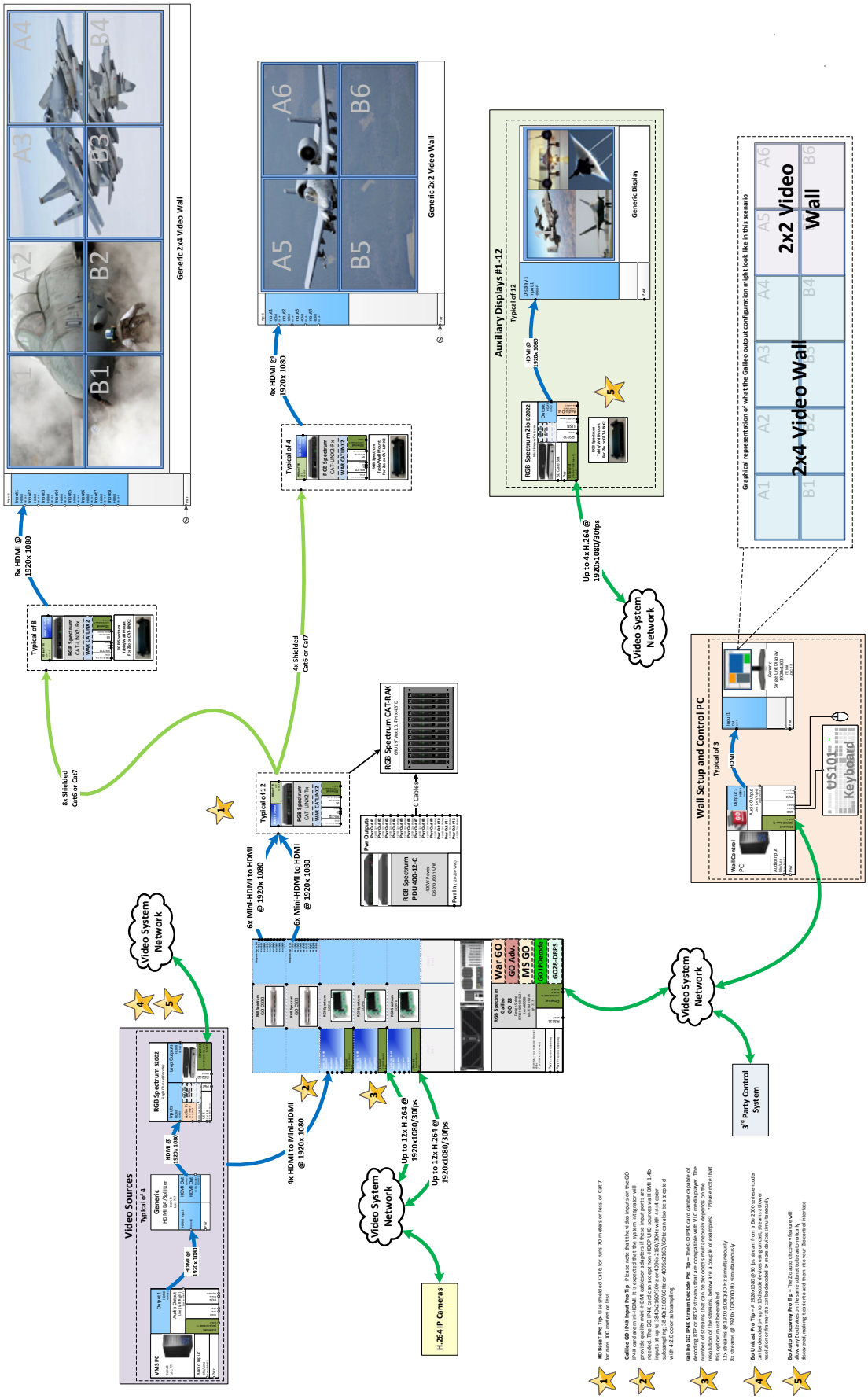
MEDIAWALL V SAMPLE PROJECT DIAGRAM



HDBaseT Pro Tip- Use shielded Cat6 for runs 70 meters or less, or Cat7 for runs 100 meters or less

MWV Embedded HDMI Audio Routing Pro Tip- Embedded audio from HDMI sources can be routed through AUX and SDM outputs of the MediaWall V. The source audio can be heard either by connecting the AUX/SDM ports to an output device with speakers or by extracting the audio via HDMI audio de-embedder and then using it to feed a traditional audio system.

GALILEO SAMPLE PROJECT DIAGRAM



Numbers/Symbols

1080I

1080 lines of interlaced video (540 lines per field). An HD format that refers to 1920x1080 resolution in a 1.78 aspect ratio.

1080P

1080 lines of progressively-scanned video (1080 lines per frame). An HD format that refers to 1920x1080 resolution in a 1.78 aspect ratio.

3G-SDI

A single 2.97 Gbps serial digital interface for high definition video up to 1920x1080, standardized in SMPTE 424M, that will replace dual-link HD-SDI.

4:2:2

The ratio of the sampling frequencies of the single luminance channel to the two color difference channels. For every four luminance samples, there are two samples of each color difference channel. This process is known as chroma subsampling.

4K

Technically 4K refers to a pixel resolution of 4096x2160 which is mainly used in digital cinema. 4K is also known as UHD (Ultra HD), which has a resolution of 3840x2160.

4:4:4

A sampling ratio that has equal amounts of the luminance and both chrominance channels. This process allows the full bandwidth video signal to pass through and does not introduce any chroma subsampling.

720P

720 lines of progressively-scanned video (720 lines per frame). An HD format that refers to 1280x720 resolution in a 1.78 aspect ratio.

A

AACS (ADVANCED ACCESS CONTENT SYSTEM)

A standard for content distribution and digital rights management for prerecorded and recorded optical media for consumer use with PCs and CE devices, currently used on the Blu-ray format. Consists of a set of embedded decryption keys within the source device, and a set of keys encoded in the content that describes each of the playback devices licensed to use the content.

A/D OR ADC

Analog to Digital (converter).

AES/EBU

Audio Engineering Society/European Broadcasting Union. A standard for digital audio transfer, whose specification was developed by the AES and EBU. The AES/EBU digital interface is usually implemented on 3-pin XLR connectors. One cable carries both left- and right-channel audio data to the receiving device.

AES3

A digital audio standard defined by the Audio Engineering Society, also known as “AES/EBU.” S/PDIF (Sony/Philips Digital Interconnect Format) is a consumer-grade variant of this standard.

AES (ADVANCED ENCRYPTION STANDARD)

A data encryption standard announced in 2001 by the National Institute of Standards and Technology (NIST) and approved by the US National Security Agency. AES 128 bit encryption is used in the HDCP 2.0 standard.

ANALOG

Information represented by a continuous range of values.

ANALOG SUNSET

A term that originally referred to the conversion from analog television broadcasting to digital television. The term now more commonly refers to a provision in the AACS Adopter Agreement which states that after December 31, 2010, manufacturers could no longer make new Blu-ray Disc players that have high-definition (HD) component outputs, and after December 2013, Blu-ray players that use analog outputs to play AACS-protected content cannot be made or sold.

ASPECT RATIO

The ratio of the horizontal dimension to the vertical dimension of an image. In viewing screens, standard TV is 4:3, or 1.33:1; HDTV is 16:9, or 1.78:1.

ATSC

Advanced Television Systems Committee. The ATSC was formed to establish voluntary technical standards for advanced television systems, including digital high definition television (HDTV).

B

BANDWIDTH

The range of frequencies over which signal amplitude remains constant (within some limits) as it passes through a system. In analog terms, the lower and upper frequency limits are defined as the half power, or -3 dB signal strength, compared to the signal strength of the middle frequency, or the maximum signal strength of any frequency, expressed as xx Hz to xx kHz (or MHz) @ -3 dB. In digital terms, it is the maximum bit rate at a specified error rate, expressed in bits per second (bps).

BIT

A binary representation of 1 or 0. A bit is the smallest unit of information in a computer.

BIT DEPTH

The number of bits per pixel. Bit depth determines the number of shades of gray or variations of color that can be displayed by a computer monitor. For example, a monitor with a bit depth of 1 can display only black and white; a monitor with a bit depth of 16 can display 65,536 colors; a monitor with a bit depth of 24 can display 16,777,216 colors.

BIT RATE

The rate at which the compressed bit stream is delivered from the storage medium to the input of a decoder. The digital equivalent of bandwidth. The rate of digital data transmission, commonly expressed in bits per second (bps), kilobits per second (kbps), Megabits per second (Mbps), or Gigabits per second (Gbps).

BLU-RAY

An optical disc storage medium developed by Sony as the replacement for DVD. A Blu-Ray disc is capable of storing high-definition video, audio, and data with a capacity of 50GB per disc. The Ultra HD Blu-ray disc format, introduced in 2016, supports 4K UHD (3840 × 2160 resolution) video at frame rates up to 60 frames per second.

B-Y

One of the color difference signals used in the NTSC system, obtained by subtracting luminance (Y) from the blue camera signal (B).

C

C

Chroma or chrominance. The color information in a digital television signal. The symbols used for the chrominance signals are Cr and Cb.

CEC (CONSUMER ELECTRONICS CONTROL)

An optional protocol in the HDMI 1.0 specification that allows HDMI devices to pass control functions to all devices within the system.

CAT-5

Category 5. A network cabling standard that consists of four unshielded twisted pairs of copper wire terminated by RJ-45 connectors. CAT-5 cabling supports data rates up to 100 Mbps. CAT-5 is based on the EIA/TIA 568 Commercial Building Telecommunications Wiring Standard.

CAT-5E

Enhanced Category 5. The standard for the next higher grade of unshielded twisted pair (UTP) beyond Category 5. The CAT-5e specification was developed to provide more robust support for 1000Base-T. CAT-5e specifies tighter limits than CAT-5 for Near-End Crosstalk (NEXT), Equal-Level Far-End Crosstalk (ELFEXT), and return loss.

CAT-6

Category 6. The standard for the next higher grade of unshielded twisted pair (UTP) cabling beyond CAT-5e. The standard defines components (cable and connecting hardware) and cabling (basic link and channel) for Category 6 channels, as well as Level III field tester requirements.

CAT-7

Category 7. The cable standard for 10 Gigabit Ethernet using shielded twisted pair (STP) cable. Cat-7 features strict guidelines for crosstalk and system noise, requiring shielding for each pair of wires and the cable as a whole.

CLADDING

In fiber optics, the material that surrounds the core of an optical fiber. Its lower index of refraction, compared to that of the core, causes the transmitted light to travel down the core.

CLIFF EFFECT

The sudden loss of digital signal reception. Unlike analog signals, which gradually fade when signal strength decreases or electromagnetic interference or multi-path increases, a digital signal provides data which is either perfect or non-existent at the receiving end.

CODEC

A device or computer program for encoding/decoding a digital data stream. Codec processing includes data compression for efficient signal transmission and storage.

COLOR MODEL

The mathematical representation of a color. In AV, the two most common video color models are RGB and YUV. RGB describes the three color primaries, Red, Green, and Blue. YUV (or Component) describes the luminance channel (Y) and two chrominance channels, U (Blue minus Y) and V (Red minus Y), with the remainder representing Green. RGB is most commonly used with high-resolution computer video signals, while YUV is the primary color space for motion video and television transmission because it requires less bandwidth.

COMPONENT DIGITAL

A digital representation of a component analog signal set, most often Y, B-Y, R-Y. The encoding parameters are specified by CCIR 601. The parallel interface is specified by ITU-R BT.601-2 656 and SMPTE 125M (1991).

COMPONENT VIDEO

Video which exists in the form of three separate signals, all of which are required in order to completely specify the color picture. Component video comes in several varieties: RGB (red, green, blue), YUV (luminance, sync, and red/blue) and Y/C (luminance and chrominance).

COMPOSITE VIDEO

A type of video signal in which the red, blue, green and sometimes the audio signals are mixed together.

CORE

The light-conducting central portion of an optical fiber, composed of material with a higher index of refraction than the cladding. The portion of the fiber that transmits light.

CSMA/CD (CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DETECTION)

An Ethernet network control protocol in which (a) carrier sensing is used and (b) while a transmitting data station that detects another signal while transmitting a frame, stops transmitting that frame, waits for a jam signal, and then waits for a random time interval before trying to send that frame again.

D

DA

Distribution amplifier. A device that allows connection of one input source to multiple, isolated (buffered) outputs.

D/A OR DAC

Digital to analog (converter).

DCT (DISCRETE COSINE TRANSFORM)

A Fourier-related transform used in many video compression codecs including JPEG, MPEG, MPEG-2, MPEG-4 and H.264. DCT converts an image from a spatial domain to a frequency domain.

DDC

Display Data Channel. A VESA (Video Electronics Standards Association) standard communications channel between computers and display devices. The DDC is used to pass Extended Display Identification Data (EDID), which is stored in the monitor and describes its characteristics (vendor name, serial number, frequency range, etc.).

DDWG

Digital Display Working Group. The DDWG is an open industry group led by Intel, Compaq, Fujitsu, Hewlett Packard, IBM, NEC, and Silicon Image. They develop standards for digital displays, such as Digital Visual Interface (DVI).

DEEP COLOR

Deep Color is used to describe a gamut consisting of a billion or more colors. Deep Color defines colors using an algorithm that can specify any color in that is found in nature. Deep Color eliminates on-screen color banding, for tonal transitions that are smooth and graduations of color that are very subtle. It enables increased contrast ratio, and can represent many times more shades of gray between black and white.

DESTINATION RECTANGLE

In a video wall application, the destination rectangle refers to the output window's size and screen position on the wall. Each destination rectangle represents a source rectangle mapped to a specific size and position on the display.

DISPLAYPORT

A digital interface developed by the Video Electronics Standards Association (VESA), designed to replace older standards like DVI and VGA. DisplayPort can emit an HDMI signal through the use of a passive adapter connected to a port that supports dual-mode.

DPCP (DISPLAYPORT CONTENT PROTECTION)

DPCP is a content-protection scheme for DisplayPort, developed by Advanced Micro Devices. Like HDCP 2.0, DPCP uses AES 128 encryption.

Refers to technologies like HDCP, DTCP, and DPCP that are used to control access to and protect commercially-available content. DRM is used primarily to prevent piracy, the unauthorized duplication and distribution of copyrighted material.

DTCP (DIGITAL TRANSMISSION CONTENT PROTECTION)

A method of protecting audio and audiovisual content on a network over high bandwidth bidirectional digital interfaces. Unlike HDCP, DTCP provides the ability to copy or store content. DTCP is the encryption standard used to protect content which is sent over the IEEE 1394 (or FireWire) standard.

DUAL-LINK DVI

Dual-link DVI supports devices requiring high video bandwidth by using two TMDS links on all 24 pins on a DVI connector, thus providing twice the bandwidth of single-link DVI. Both links use the same clock channel.

DUAL-LINK HD-SDI

A serial digital interface standard defined in SMPTE 372M that consists of a pair of SMPTE 292M links and provides a nominal 2.970 Gbps interface used in applications (such as digital cinema or HDTV 1080p) that require greater fidelity and resolution than standard HDTV can provide.

DUPLEX

Bi-directional signal over two fiber paths between source and destination.

DVI

Digital Visual Interface is a digital video display connectivity standard developed by DDWG (Digital Display Working Group). The interface is designed to transmit uncompressed digital video and can be configured to support multiple modes such as DVI-D (digital only), DVI-A (analog only), or DVI-I (digital and analog). DVI uses TMDS (Transition Minimized Differential Signaling) from Silicon Image and DDC (Display Data Channel) from VESA.

DWT (DISCRETE WAVELET TRANSFORM)

DWT converts an image from a spatial domain to a wavelet domain.

E

EDID (EXTENDED DISPLAY IDENTIFICATION DATA)

EDID is the information transmitted from a display to a source that details characteristics about the display device, including native resolution and vertical interval refresh rate requirements. This information is conveyed over the DDC (Display Data Channel).

EQ (VIDEO)

Equalization. The process of altering the frequency response of a signal to compensate for losses and other distortions due to long cable lengths or poor quality cabling and connectors.

EYE PATTERN

A visual representation of a repetitively sampled digital signal on an oscilloscope that gives some indication of the signal integrity. The more “open” the eye appears, the lower distortion that appears on the signal.

F

FIBER

Fiber optic cabling. The components of a fiber optic cable includes the core, surrounded by the cladding, and a coating, or buffer, for protection. Specific optical properties of the core and cladding enable light to be contained within the core as it travels along the fiber.

FPS (FRAMES PER SECOND)

A measure of film or video display rates. Each frame represents a still image which when displayed in succession, creates the illusion of motion. The more frames per second, the smoother the motion will appear.

G

GHZ

Gigahertz. One billion cycles per second.

GIGA

The prefix abbreviation for billion. (G) One G-Byte = 1 billion bytes.

H

H.264 ENCODING

A video compression format, also known as MPEG-4 Part 10 or MPEG-4 AVC (Advanced Video Coding). H.264 is actually a family of standards, which includes 15 different sets of capabilities (or “profiles”) that use different algorithms and encoding techniques for compressing files. Among the most commonly used profiles are Baseline Profile, Main Profile, and High Profile.

H.265 ENCODING

A video compression format, also known as MPEG-H Part 2 or HEVC (High Efficiency Video Coding). One of the differences between the two formats is that H.265 uses a larger difference-coding area resulting in improved compression efficiency. H.265 files can be up to half the compressed file size or bit rate as H.264 files while maintaining a high visual quality.

HDBaseT

HDBaseT is a connectivity technology optimized for multimedia distribution. HDBaseT is capable of delivering uncompressed full HD digital video, audio, 100BaseT Ethernet, up to 100 watts of power over cable and various control signals through a single 100m/328ft CAT-6 cable with RJ45 connectors. It supports both USB and HDCP.

HDCP (HIGH-BANDWIDTH DIGITAL CONTENT PROTECTION)

A specification developed by Intel Corporation to protect digital entertainment content across the DVI/HDMI interface. HDCP is a mandatory for licensing the HDMI interface, but optional for DVI. It can also be used in DisplayPort and HDBaseT interfaces. The HDCP content protection mechanism includes three elements: 1) Authentication of HDCP receivers to their immediate upstream connection (to an HDCP transmitter). The authentication protocol is the mechanism through which the HDCP transmitter verifies that a given HDCP receiver is licensed to receive HDCP. 2) Revocation of HDCP receivers that are determined by the DCP (digital content licensing organization) to be invalid. 3) HDCP encryption of audiovisual content over the HDCP-protected interfaces between HDCP transmitters and their downstream HDCP receivers. The HDCP specification refers to three basic system components: sources, sinks, and repeaters.

HDMI (HIGH-DEFINITION MULTIMEDIA INTERFACE)

HDMI is an uncompressed, all-digital audio/video interface. It was developed primarily for consumer electronics applications, but has found its way into commercial applications because of its wide acceptance on display and source devices. HDMI supports standard, enhanced, or high-definition video, plus multi-channel digital audio on a single cable. It transmits all ATSC HDTV standards and supports 8-channel, 192kHz, uncompressed digital audio and all currently-available compressed formats. HDMI can use HDCP to encrypt the signal if required by the source device.

HD-SDI

High-definition version of SDI specified in SMPTE-292M. This standard transmits audio and video over a single coaxial cable with a data rate of 1.485 Gbps.

HEVC (HIGH EFFICIENCY VIDEO CODING)

A video compression format, also known as MPEG-H Part 2 or H.265. One of the differences between the two formats is that HEVC uses a larger difference-coding area resulting in improved compression efficiency. HEVC files can be up to half the compressed file size or bit rate as H.264 files while maintaining a high visual quality.

HOT PLUG DETECT

A feature of digital technologies (including DVI, HDMI, and USB) which allows a host device to automatically detect the presence of a new device. When the new device is connected, the Hot Plug Detect circuit senses it and prepares the system to either send or receive a data stream.

I

ICT (IMAGE CONSTRAINT TOKEN)

As part of the AACS, the Image Constraint Token is a “flag” that restricts the resolution for analog outputs on video source devices to 960x540. Its use as part of the HDCP process is voluntary, dependent on the content provider.

INTERLACED

Display system in which two interleaved fields are used to create one frame. The number of field lines is one-half of the number of frame lines. Each field is drawn on the screen consecutively.

ITU-R BT.601

A standard published in 1982 by the International Telecommunication Union (ITU; formerly CCIR) for encoding interlaced analog video signals in digital video form. ITU-R BT.601 deals with the conversion from component RGB to YCbCr, the digital filters used for limiting the bandwidth, the sample rate (defined as 13.5 MHz), and the horizontal resolution (720 active samples).

J

JITTER

The variation of a digital signal’s significant instants (such as transition points) from their ideal positions in time. Jitter results from the use of a low quality cable or excessive cable length.

K

KSV (KEY SELECTION VECTOR)

In HDCP, the KSV is a set of numbers acting as a “key” used in the authentication process. Each KSV consists of 40 bits (one bit for each HDCP key), with 20 bits set to 0 and 20 bits set to 1.

KVM

An abbreviation for keyboard, video, mouse. Typically refers to a hardware device that allows a user to control multiple computers from a single keyboard, video monitor and mouse.

L

LOSS BUDGET

An accounting of overall attenuation in an optical transmission system.

M

MACROBENDING

In a fiber, all macroscopic deviations of the fiber's axis from a straight line, that will cause light to leak out of the fiber, causing signal attenuation.

MATRIX SWITCHER

A device with multiple inputs and outputs that allows an input source to be connected to one or more outputs.

MECHANICAL SPLICE

An optical fiber splice accomplished by fixtures or materials, rather than by thermal fusion.

MHZ

Megahertz. One million hertz (cycles per second). Video bandwidth is measured in megahertz.

MICROBEND

A defect in an optical fiber at the core/cladding boundary, caused by mechanical stress that results in leakage of light from the core to the cladding.

MMF (MULTIMODE FIBER)

An optical fiber that has a core large enough to propagate more than one mode of light. The typical diameter of multimode optical fiber is 62.5 micrometers.

MODE

A propagation path for light within an optical fiber.

MPEG-4

A method developed by the Moving Picture Experts Group (MPEG) of defining compression of audio and video using discrete cosine transforms (DCT). There are many standards, known as parts, that compose the MPEG-4 standard that cover such things as 3D (stereoscopic) video, IP distribution, audio, and more.

MULLION

The vertical and horizontal frame around a display device formed by adjacent bezels in a video wall. Although modern display devices have very narrow bezels, the effects of the physical offsets between the viewable areas in a multi-display video wall must be taken into account or the displayed wall image will have apparent discontinuities between the different display panels.

MULTICAST STREAM

The delivery of a one-to-many stream to a group of destination computers simultaneously in a single transmission, creating automatic copies only when network topology requires it. In multicast transmissions, each packet is sent only once; the network nodes replicate packets as required to reach multiple receivers.

MULTIVIEWER

Display processor that displays multiple input video/graphic sources on a single output device.

N

NATIVE RESOLUTION

The original resolution of a source or a display device.

NON-BLOCKING

Non-blocking is the ability of a switcher or similar device to route any input to any or all available outputs simultaneously.

O

OPTICAL FIBER

A glass or plastic fiber that has the ability to guide light along its axis. The three parts of an optical fiber are the core, the cladding, and the coating or buffer.

P

PCM (PULSE CODE MODULATION)

A method used to digitally represent an analog signal. PCM is the standard form of digital audio in computers and the compact disc (CD) "red book" format, as well as the standard used for the audio portion of digital video recording. PCM streams have two basic properties that determine their fidelity to the original analog signal: the sampling rate, which is the number of times per second that samples are taken; and the bit depth, which determines the number of possible digital values that each sample can take.

PIXEL PERFECT

An image where the number of pixels is the same as in the image source, and where the pixels are perfectly aligned to the pixels in the source.

PROGRESSIVE (SCANNING)

A system of video scanning where lines of a picture are transmitted consecutively, rather than interleaved.

PROPAGATION DELAY

The amount of time required for a certain amount of data to be transferred from a sender to a receiver.

R

REAL-TIME

The delivery of data as it is collected.

RECLOCKING

A process that restores the original characteristics of a digital signal.

REPEATER

In HDCP terminology, a repeater is a device that accepts content, decrypts it, then re-encrypts and retransmits the data. It may perform some signal processing, such as upconverting video to a higher-resolution format, or splitting out the audio portion of the signal. Repeaters have both HDMI inputs and outputs. Examples include home theater audiovisual receivers that separate and amplify the audio signal, while re-transmitting the video for display on a TV. A repeater could also simply send the input data stream to multiple outputs for simultaneous display on several screens.

RESOLUTION

Resolution determines how sharp or "crisp" an image will appear. It is usually recorded as the number of pixels in the horizontal axis by the number of horizontal lines.

RESOLUTION (HORIZONTAL)

The amount of detail in a horizontal direction in a video image. It is expressed as the number of distinct vertical lines that can be seen in the width of the picture.

RESOLUTION (VERTICAL)

The amount of resolvable detail in a vertical direction in a video image. It is expressed as the number of distinct horizontal lines that can be seen in the height of the picture.

RS-232 (OR RS-232C)

A single-ended (unbalanced) interconnection standard for serial data communications, developed by the Electronic Industries Association (EIA). The standard supports two types of connectors: a 25-pin D-type connector and a 9-pin D-type connector. The maximum permissible line length under the specification is approximately 15 meters.

RTCP (RTP CONTROL PROTOCOL)

RTCP provides statistics and control information for an RTP stream flow.

RTP (REAL TIME PROTOCOL)

An IETF standard for streaming audio and video over IP networks. RTP is used with the RTP Control Protocol (RTCP). While RTP carries the media streams (e.g., audio and video), RTCP is used to monitor transmission statistics and quality of service (QoS) and aids synchronization of multiple streams.

RTSP (REAL TIME STREAMING PROTOCOL)

A network control protocol designed to control streaming media servers.

S

SCALING

The process of changing or converting a video or graphic signal from one resolution to another, in order to fit the native rate (or pixel size) of a display device, without changing its shape.

SDI (SERIAL DIGITAL INTERFACE)

A 10-bit, scrambled, polarity independent interface, based on a 270 Mb/s data rate, with common scrambling for both component ITU-R 601, composite digital video, and four channels of embedded digital audio.

SIMPLEX

One-way signal over a single fiber path between source and destination.

SINGLE-LINK DVI

A single-link DVI connection consists of four TMDS links, each transmitting data from the source to the device over one twisted wire pair. Three of the links correspond to the RGB components of the video signal: red, green, blue (for a total of 24 bits per pixel.) The fourth link carries the pixel clock. Each TMDS link carries binary data at ten times the pixel clock reference frequency, for a maximum data rate of 1.65 Gbps × 3 data pairs for single-link DVI. Single-link DVI is capable of resolutions up to 1920x1200.

SINGLE-LINK HD-SDI

Also known as simply HD-SDI to differentiate it from dual-link HD-SDI and based on SMPTE 292M, single-link HD-SDI is capable of bitrates up to 1.485 Gbps.

SINK

In HDCP terminology, it is the device that renders the content for display so it can be viewed. Examples include TVs and digital projectors. A sink has one or more HDCP/HDMI receivers.

SMF (SINGLE MODE FIBER)

A small-core optical fiber through which only one mode will propagate. The typical diameter is 8-9 microns.

SMPTE

Society of Motion Picture and Television Engineers. A global organization, based in the United States, that sets standards for baseband visual communications. This includes film as well as video and television standards.

SMPTE 259M

SMPTE standard that defines the serial digital interface (SDI).

SMPTE 292M

SMPTE standard that defines the high-definition serial digital interface (HD-SDI).

SMPTE 372M

The SMPTE standard that defines dual-link HD-SDI, which provides a nominal 2.97 Gbps interface used in applications (such as digital cinema or HDTV 1080p) that require greater fidelity and resolution than standard HDTV can provide. SMPTE 372M defines a full bandwidth, 4:4:4 RGB color space on two coaxial cables. SMPTE 372M is most commonly associated with dual-link HD-SDI, wherein two coaxial cables are used to carry alternate pixels, thus doubling the data rate and available resolution. Dual-link HD-SDI is sufficient for 1080/60p and 1080/24Psf video streams; however, the "Super2k" format used in digital cinema, 2048x1080, progressive scan, 4:4:4 RGB color space, is the highest data rate possible with one dual-link HD-SDI connection.

SMPTE 424M

The SMPTE standard that defines 3G-SDI, which is intended to replace dual-link HD-SDI. It allows for bitrates of 2.97 Gbps over a single-link coaxial cable.

SOURCE

In HDCP terminology, it is the device that sends the content to be displayed.

Examples include set-top boxes, DVD and Blu-ray players, and computer video cards. A source has only an HDCP/HDMI transmitter.

SOURCE RECTANGLE

A rectangular portion of a full-size input. Typically, the source rectangle contains the entire source, but it can also contain a cropped portion. The source rectangle for each input is defined in terms of the input image's top-left pixel position in coordinate space, and the image's width and height.

S/PDIF (SONY/PHILIPS DIGITAL INTERCONNECT FORMAT)

A digital audio interface for compressed or uncompressed digital audio co-developed by Sony and Philips Electronics. The signal can be transmitted over either a coaxial cable with RCA connectors or a fiber optic cable with TOSLINK connectors. S/PDIF is based on the professional AES3 interconnect standard.

SPATIAL COMPRESSION

Spatial compression involves reordering or removing information to reduce file size. Spatial (or intraframe) compression is applied to each individual frame of the video, compressing pixel information as though it were a still image.

T

TEMPORAL COMPRESSION

Temporal (or interframe) compression, as the name suggests, operates across time. It compares one still frame with an adjoining frame and, instead of saving all the information about each frame into the digital video file, only saves information about the differences between frames (frame differencing).

TMDS (TRANSITION MINIMIZED DIFFERENTIAL SIGNALING)

A standard developed by Silicon Image, Inc. for transmitting high-speed serial data, used by the DVI and HDMI video interfaces, as well as other digital communication interfaces.

TOTAL EDID MANAGER

A proprietary EDID management technology developed by RGB Spectrum found in many RGB Spectrum products. It offers the user a choice between fixed, pass-through, or emulated EDID, and eliminates the need for external EDID emulators.

TRI-LEVEL SYNC

A synchronization signal is used in high definition analog formats, which has a three-level pulse that goes from 0 to -300 mV and then rises to +300 mV before returning to 0 mV. The transition of the positive-going sync signal through the reference voltage is the sync trigger.

Y

Y

Luma or luminance. The brightness of an image or the black and white portion of a video signal.

YCbCr

Digital color difference. One of two primary color spaces used to represent digital component video (the other is RGB).

YPbPr

Analog color difference. The color space for progressive-scan (non-interlaced) component video.

Y, R-Y, B-Y

Color difference signal designation. Y corresponds to the luminance signal; R-Y corresponds to the red minus luminance signal, and B-Y corresponds to the blue minus luminance signal. After luminance is subtracted from red and blue, the remainder is considered to be the green portion of the RGB video signal. These signals are derived as follows:

Y = 0.3 red + 0.59 green + .11 blue

R-Y = 0.7 red - 0.59 green - 0.11 blue

B-Y = 0.89 blue - 0.59 green - 0.3 red

YUV

A video component system consisting of luminance (Y) and two color components directly related to the red and blue components. Y, Pb, Pr and Y, Cb, Cr are subsets of this format, used in presentation, multimedia and professional video applications.

Printed in the United States of America; 3rd printing, January 2018

Corporate Headquarters

1101 Marina Village Parkway, Suite 101

Alameda, California 94501

Tel: (510) 814-7000

Web: www.rgb.com

Email: sales@rgb.com

Visit Our Website for Worldwide Offices

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